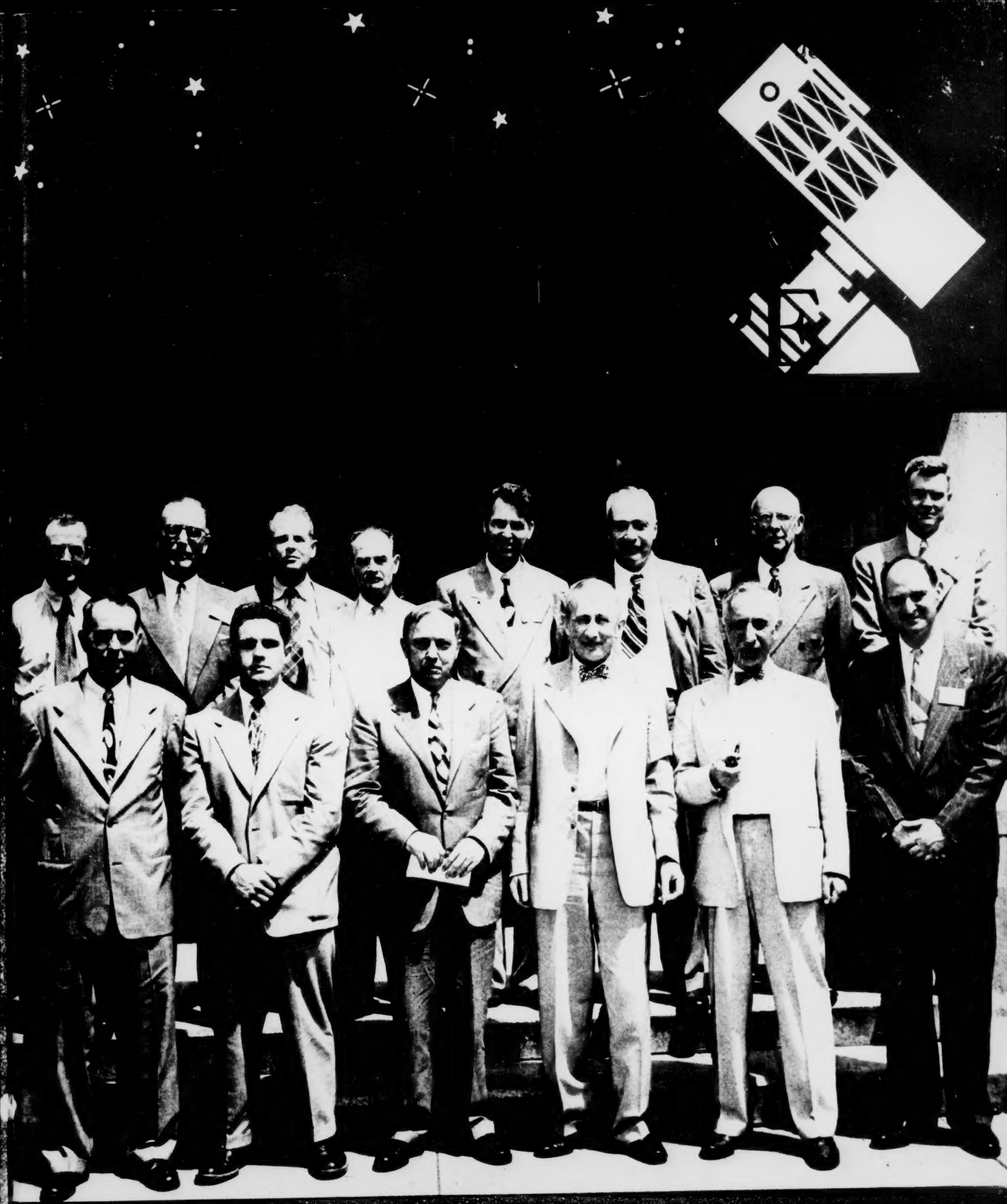

Planetarium Notes

BALTIMORE: *Davis Planetarium.* Maryland Academy of Sciences, Enoch Pratt Library Building, 400 Cathedral St., Baltimore 1, Md., Mulberry 2370.

SCHEDULE: 4 p.m. Monday, Wednesday, and Friday; Thursday evening, 7:45, 8:30, 9:30 p.m. Admission free. Spitz projector. Director, Paul S. Watson.

BOSTON: *Little Planetarium.* Boston Museum of Science, Science Park, Boston 15, Mass. Richmond 2-1410.

SCHEDULE: Tuesday thru Friday at 3:30 p.m.; Saturday, 2:00 and 3:30 p.m.; Sunday, 3 and 4 p.m. Spitz projector. In charge, Charles A. Federer, Jr.

BUFFALO: *Buffalo Museum of Science Planetarium.* Humboldt Parkway, Buffalo, N. Y., GR-4100.

SCHEDULE: Sundays, 2:00 to 5:30 p.m. Admission free. Spitz projector. For special lectures address Elsworth Jaeger, director of education.

CHAPEL HILL: *Morehead Planetarium.* University of North Carolina, Chapel Hill, N.C.

SCHEDULE: Daily at 8:30 p.m.; Saturday and Sunday at 3:00 p.m. Zeiss projector. Director, Roy K. Marshall.

CHICAGO: *Adler Planetarium.* 900 E. Achsah Bond Drive, Chicago 5, Ill., Wabash 1428.

SCHEDULE: Mondays through Saturdays, 11 a.m. and 3 p.m.; Sundays, 2:30 and 3:30 p.m. Zeiss projector. Director, Wagner Schlesinger.

KANSAS CITY: *Kansas City Museum Planetarium.* 3218 Gladstone Blvd., Kansas City 1, Mo., Chestnut 2215.

SCHEDULE: Wednesday and Saturday, 3:30 p.m.; Sunday, 3:00 and 5:00 p.m. Spitz projector. Director, Charles G. Wilder.

LOS ANGELES: *Griffith Observatory and Planetarium.* Griffith Park, P.O. Box 9787, Los Feliz Station, Los Angeles 27, Calif., Olympia 1191.

SCHEDULE: Wednesday and Thursday at 8:30 p.m. Friday, Saturday, and Sunday at 3 and 8:30 p.m.; extra show on Sunday at 4:15 p.m. Zeiss projector. Director, Dinsmore Alter.

NEW YORK CITY: *Hayden Planetarium.* 81st St. and Central Park West, New York 24, N. Y., Endicott 2-8500.

SCHEDULE: Mondays through Fridays, 2, 3:30, and 8:30 p.m.; Saturdays, 11 a.m., 2, 3, 4, 5, and 8:30 p.m.; Sundays and holidays, 2, 3, 4, 5, and 8:30 p.m.; Wednesdays and Fridays, 11 a.m., for school groups. Zeiss projector. Curator, Gordon A. Atwater.

PHILADELPHIA: *Fels Planetarium.* Franklin Institute, 20th St. at Benjamin Franklin Parkway, Philadelphia 3, Pa., Locust 4-3600.

SCHEDULE: Tuesdays through Sundays, 3 p.m.; Saturdays, 11 a.m.; Saturdays, Sundays, and holidays, 2 p.m.; Wednesdays, Fridays, and Saturdays, 8:30 p.m. Zeiss projector. Director, I. M. Levitt.

PITTSBURGH: *Buhl Planetarium and Institute of Popular Science.* Federal and West Ohio Sts., Pittsburgh 12, Pa., Fairfax 4300.

SCHEDULE: Mondays through Saturdays, 2:15 and 8:30 p.m.; Sundays and holidays, 2:15, 3:15 and 8:30 p.m. Zeiss projector. Director, Arthur L. Draper.

SPRINGFIELD, MASS.: *Seymour Planetarium.* Museum of Natural History, Springfield 5, Mass.

SCHEDULE: Tuesdays, Thursdays, and Saturdays at 3 p.m.; Tuesday evenings at 8 p.m.; special star stories for children on Saturdays at 2 p.m. Admission free. Korkosz projector. Director, Frank D. Korkosz.

STAMFORD: *Stamford Museum Planetarium.* Courtland Park, Stamford, Conn.

SCHEDULE: Sunday, 4:15 p.m. Special showings on request. Admission free. Spitz projector. Director, Robert E. Cox.

Sky and TELESCOPE

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CHARLES A. FEDERER, JR., *Editor;* HELEN S. FEDERER, *Managing Editor*

LETTERS

Sir:

At midnight, June 21-22, I observed the sun through the porthole of my stateroom aboard the S.S. **Saltdal,** at Oksfjord, Norway, with a pair of 7 x 50 binoculars using two green filters superposed in front of one of the eyepieces. The ship's position was roughly 70° 50′ N., 24° 05′ E.

There was a sunspot easily visible near the center of the sun. It was too small for the naked eye. The sun was extremely bright for its altitude, which was an estimated six degrees.

STEPHEN H. FORBES
Moylan, Pa.

Sir:

The Kansas City Museum has installed a small planetarium with a Spitz projector. It is located in one of our auxiliary buildings, seats 60 people, and has recently been air-conditioned. Four public lectures are held each week, on Wednesday and Saturday at 3:30 p.m., and at 3:00 and 5:00 on Sunday afternoons. Special demonstrations can be arranged for groups of 20 or more through the educational department of the museum.

Two planetarium units for school groups have been worked out by the museum in co-operation with the curriculum division of the Kansas City public schools. The first unit, devised for the 6th grade, is on the solar system; the second, for the 7th grade, is on stars and constellations. A teacher's syllabus has been distributed throughout the school system, and work booklets are used by the pupils in connection with each planetarium visit.

Any readers of **Sky and Telescope** who happen to pass through Kansas City are especially invited to attend the public planetarium lectures.

CHARLES G. WILDER, director
Kansas City Museum
3218 Gladstone Blvd.
Kansas City 1, Mo.

VOL. IX, NO. 10
WHOLE NUMBER 106
AUGUST, 1950

CONTENTS

COVER: Chief participants in the dedication of the Curtis memorial Schmidt telescope of the University of Michigan's Portage Lake Observatory. Front row (left to right): Freeman D. Miller, Karl G. Henize, Harlow Shapley, Walter Baade, J. J. Nassau, and Leo Goldberg (director of University of Michigan Observatories). Back row (left to right): Giorgio Abetti (Arcetri Observatory, Italy, visiting lecturer at Michigan), Bertil Lindblad, W. W. Morgan, A. N. Vyssotsky, N. U. Mayall, R. Minkowski, Joel Stebbins, and Sidney W. McCuskey. See page 243 for a report of the symposium on galactic structure in which 11 of these astronomers participated. Photograph by University of Michigan News Service.

BACK COVER: The appearance of the granules on greatly enlarged direct photographs of the sun taken at Mount Wilson Observatory on May 6, 1936. The upper picture was made at 6:11 a.m. local time, the lower picture one minute later. Compare the regions marked with similar circles for changes that occurred in that interval. The scale of the reproduction is roughly 400 miles on the sun to one millimeter. Mount Wilson photograph. (See page 239.)

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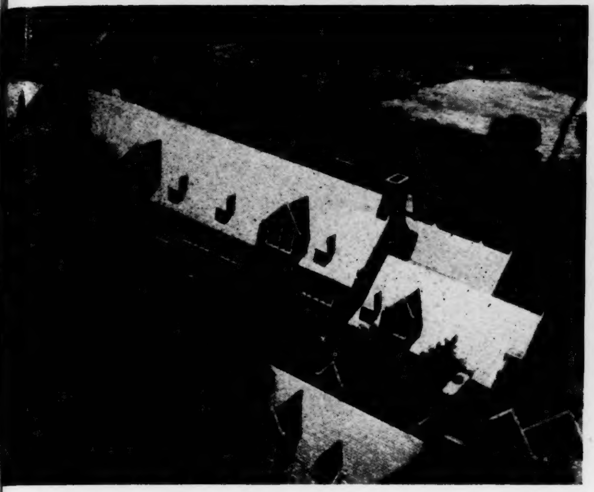
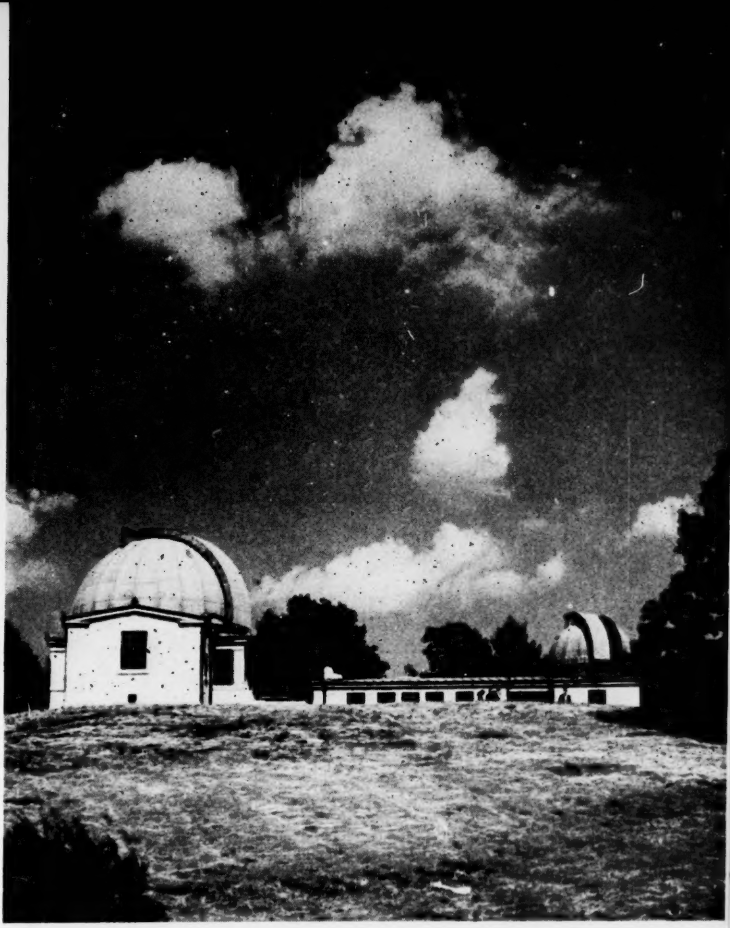




WELLESLEY PICTURES

BY ROBERT E. COX
Stamford Museum

Over 230 persons registered officially for the general convention of the Astronomical League at Wellesley College, July 1-4, 1950. The program included sessions for papers and business, regional meetings, evening lectures, observing, and a panel of experts. Orders for the proceedings of the convention are now being accepted (in advance of publication) by the Astronomical League, Science Service Building, 1719 N St., N. W., Washington 6, D. C., for 60 cents each, postpaid.

The Whitin Observatory of Wellesley College, seen from the west. At the left is the dome of the 12-inch refractor; at the right that of the 6-inch refractor. The telescopes for observing were set up at the top of the slope in the foreground. Good observing conditions prevailed for the first two evenings. The picture at the left above shows Pendleton Hall, where convention sessions and the exhibit were held, seen from the tower of Tower Court.

Dr. John C. Duncan, retiring director of the Whitin Observatory, gave the opening address on Saturday evening, speaking on "Celestial Scenery."

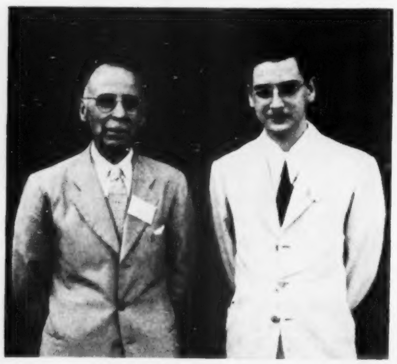
A portion of the Pendleton Hall lecture room during one of the sessions. Carl P. Richards, leaning forward in the front row center, came from Salem, Ore., to represent the societies of the Northwest region. He was re-elected vice-president of the Astronomical League.

On Sunday evening, 240 persons gathered to hear the panel of experts. From left to right, the experts were Dr. Sergei Gaposchkin, Dr. Cecilia Payne-Gaposchkin, Dr. Richard N. Thomas, Dr. Dorrit Hoffleit, Dr. Joseph Ashbrook, and Dr. William A. Calder; quizmaster Charles A. Federer, Jr., is at the right. The Drs. Gaposchkin and Dr. Hoffleit are on the staff of Harvard Observatory, and the others have their doctoral degrees from Harvard. Dr. Thomas is now at the University of Utah, Dr. Ashbrook at Yale University Observatory, and Dr. Calder at Agnes Scott College, where he has built a new observatory that he described in a lecture before the convention on Monday evening. Questions for the panel were written on cards during supper on Sunday, and a selection of the most suitable subjects for discussion was made, with flying saucers and the Velikovsky affair omitted. Not intended as a "stump the experts" program, the panel covered a very diversified range of subjects, and revealed that the audience as well as the experts had a respectable command of astronomy.

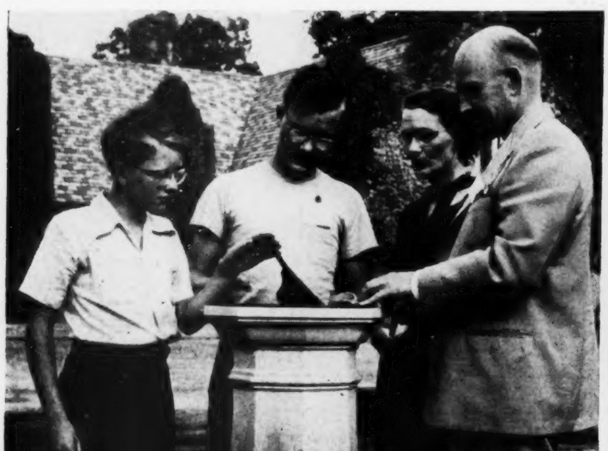
Perhaps of most importance was the question, "What are the chances for a career in astronomy," submitted by several delegates. The experts agreed that both men and women have opportunities, but that the monetary return would in general not be high. It was pointed out that astronomy, even in its more glamorous phases, included plenty of routine work, but that this was no deterrent for anyone sincerely interested.

At first, there seemed little interest among the experts in choosing the "greatest astronomer of all time," but as they warmed up to the problem, it appeared that a choice was very difficult to make. Several selected Sir William Herschel as being the leading observing and theoretical astronomer.

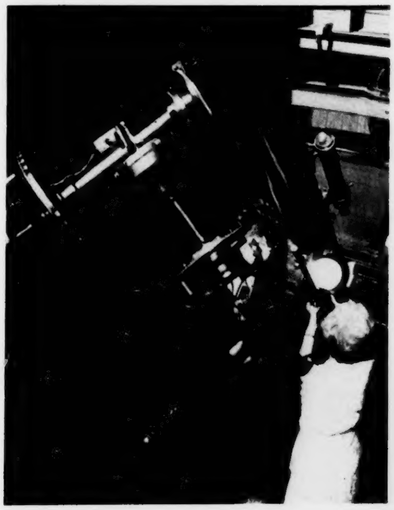
The question of whether or not photoelectric observations of variable stars would outmode photographic observations received the answer that in general each method had its place. The role of photography in the discovery of variable stars was stressed as an important one for a long time in the future.



Among registrants at the convention were Ricardo Cabanach and his son, Miguel, pictured at the left, from Santiago de Cuba. Representing the Ft. Worth Astronomical Society in Texas were Dr. and Mrs. Herman Sehested, shown with their sons examining the sundial on the Tower Court terrace. Behind the dial is John Sehested, president of the Ft. Worth Junior Astronomy Club. The group from the Montreal Centre of the Royal Astronomical Society of Canada is shown below, left to right: E. Russell Paterson, Mrs. Susanna Wright, Isabel K. Williamson, Charles M. Good, and Frank J. DeKinder. In addition to many unaffiliated individuals, members of 35 amateur groups in a score of states attended. Among other notable visitors was Dr. Eric Lindsay, of Armagh Observatory, North Ireland, who came to see the Astronomical League in action and to bring greetings from the Irish Astronomical Society. The host organizations were the Amateur Telescope Makers of Boston, the American Association of Variable Star Observers, and the Bond Astronomical Club.

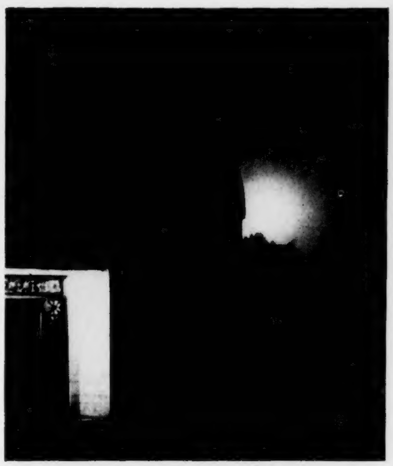


Delegates and guests at the Astronomical League convention on the terrace of Tower Court, July 2, 1950. Photo by C. V. Cosmades.



Solar observing was conducted during the day with the 6-inch Whitin Observatory refractor, here operated to project the sun's image by Professor Leah B. Allen, guest astronomer from Hood College. At the instruments section meeting, Miss Allen gave a short history of the Whitin Observatory. Assisting her and Dr. Duncan in the operation of the Whitin instruments was Nancy Weber, a former Wellesley student in astronomy. Solar observing was also carried on with amateur-made instruments set up in front of the observatory, and the Whitin spectrohelioscope was used to view prominences on the sun.

The photographs in this article, except those credited otherwise, were taken by Robert E. Cox, of the staff of the Stamford Museum, Stamford, Conn. All of his pictures were made with a Zeiss Ikonta B f/3.5 camera, using 120 film to give a picture size of 2¼ x 2¼. Mr. Cox arranged to work without the use of flashbulbs for indoor shots. Some, but not all of the indoor scenes were exposed at Weston 300 or 400 on Super XX emulsion, and developed in Von-L.

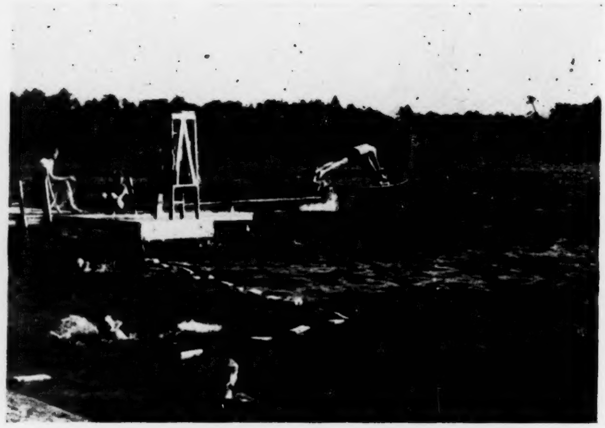


The moon, just past full, rising behind the 6-inch dome at Whitin Observatory, during the first evening's observing. Photo by Adam L. Ott, Jr.

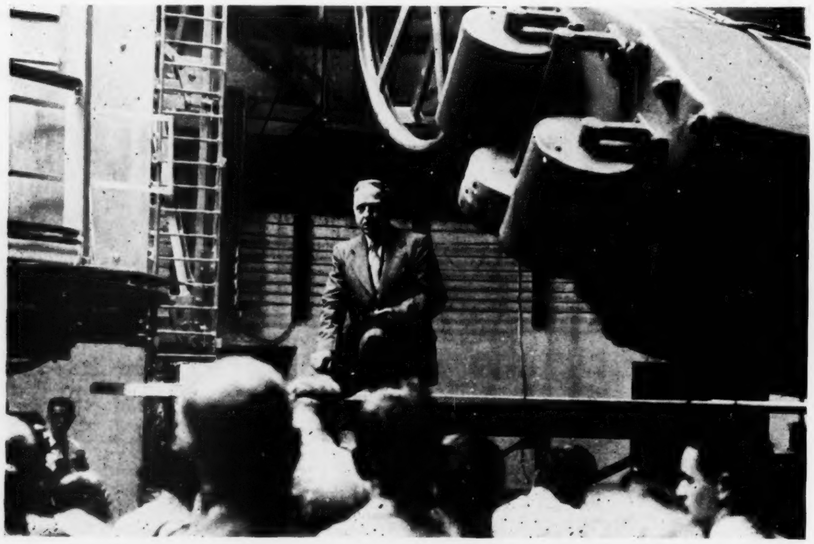
Maurice Parson, of Lansing, Mich., talks over details of his prizewinning telescope with Allyn J. Thompson, at left, author of "Making Your Own Telescope." Several other exhibit awards were made. An innovation at this convention was the recognition of the best papers presented. Donald Kimball, of New Haven, received first prize for his aurora talk, which was prepared on tape and accompanied by a collection of excellent slides. Paul Stevens, Rochester, N. Y., won second prize for his discussion of occultations of star clusters. A special award was made to Walter H. Haas, director of the Association of Lunar and Planetary Observers.

The roll call of member organizations was conducted by the executive secretary of the league, Grace C. Scholz, of Washington, D. C. Charles H. LeRoy, Pittsburgh, Pa., was re-elected president. Rolland R. LaPelle (right), of Springfield, Mass., activities chairman, reported on a survey of observing programs.

Mealtime in the dining room at Tower Court, where each repast was quite satisfying. Each table held eight persons, providing delegates ample opportunity to meet fellow amateurs from far and near.



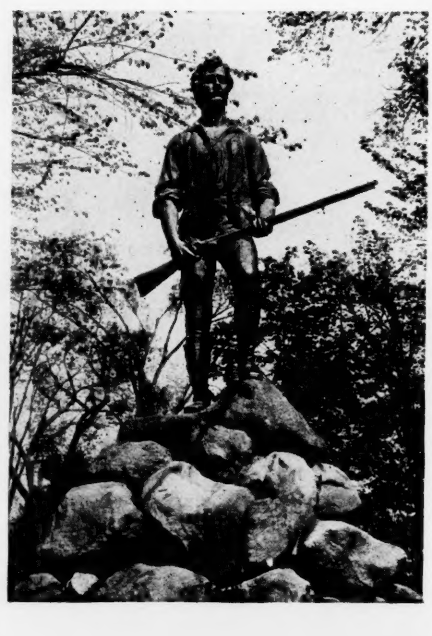
Tower Court is located on the shores of Lake Waban, where swimming privileges were enjoyed under ideal conditions. Some children of the delegates were in the vicinity of this picture most of the time.



At the Oak Ridge station, Dr. Harlow Shapley, director of Harvard College Observatory, welcomed the conventionites on the last day of the convention. He discussed Oak Ridge instruments and surveyed the work of the far-flung Harvard observing posts. He is shown here at the 61-inch Wyeth reflector, with the first serious rain of the convention period beginning to sprinkle through the open slit of the observatory dome. Other principal instruments inspected at Oak Ridge were the 26-33-inch Jewett memorial Schmidt telescope; the 24-inch reflector with photometer attachment; the 16-inch Metcalf refractor; and the 8-inch Ross-Lundin. Photo by C. A. Federer, Jr.

The entrance to Building D at Harvard headquarters in Cambridge during the opening hours of the convention on Saturday was the scene of many greetings among old friends and introductions to new ones. The open house provided opportunity to inspect the 100-year-old 15-inch refractor and the large photographic collection.

Adieu was said at the battle green in Lexington, site of the Minute Man statue, at the conclusion of a historic tour on July 4th. Engraving at right, courtesy of the Adams Press.



Turbulence in the Solar Atmosphere

By Otto Struve, *University of California*

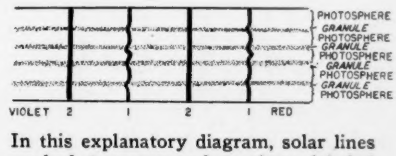
THE image of the sun projected through a medium-large telescope upon a white screen presents a granular appearance, as though its surface were covered in an irregular manner with tiny, white rice grains. This structure can be seen all over the sun's disk; it is not limited to the peripheral regions where the larger luminous areas, faculae, are seen. The individual granules have diameters of the order of one or two seconds of arc, or roughly 1,500 kilometers. They last only a few minutes as separate, identifiable objects, being dissolved quite rapidly within the uniform background of the solar photosphere. The granules are, on the average, 50° or 100° C. hotter than the intergranular spaces. It is probable that they have appreciable motions with respect to one another, and with respect to the uniform background of the photosphere, but their very short lifetimes have defied efforts to measure such motions on direct photographs.

It was suggested, long ago, that the solar granules might represent the images, in cross-section, of vertical currents in the atmosphere of the sun, corresponding to the thermals in our own atmosphere which are formed on a sunny day when an updraft of air is produced over a heated area of the earth. If this were correct, the granules should move up or down in the reversing layer of the sun, and the corresponding radial motions should be observable by the Doppler displacements of the solar spectral lines.

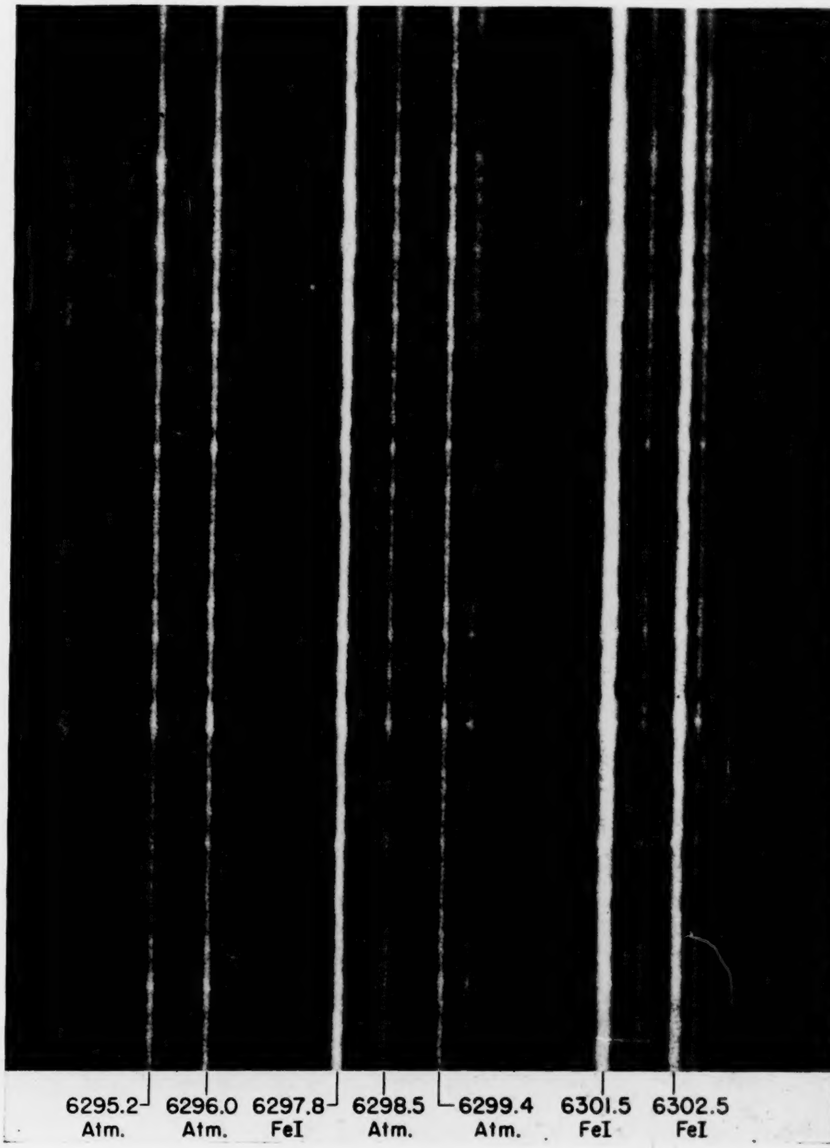
The observations required to show this effect are extremely difficult. Nevertheless, they have been successfully carried out at two observatories. About a year ago, H. H. Plaskett at the Oxford University Observatory showed me a photograph of the spectrum of the sun, taken with a long slit upon which a portion of the sun's surface was accurately focused. The image of the sun was kept stationary upon the slit, which cut across granules and intergranular spaces. At right angles to the dispersion the spectrum was not uniform in photographic blackness; the granules produced slightly darker bands, while the intergranular spaces gave rise to less-exposed bands. As usual, the Fraunhofer absorption lines cut across the spectral dispersion. These lines were not perfectly straight, but had a wavy appearance, as shown in the small diagram.

This same effect has recently been observed and measured at Mount Wilson Observatory. In an important paper published in the *Astrophysical Journal* (March, 1950), R. S. Richardson and M. Schwarzschild report on a joint investigation carried out under a co-operative arrangement between the Princeton University Observatory and the Mount Wilson and Palomar Observatories.

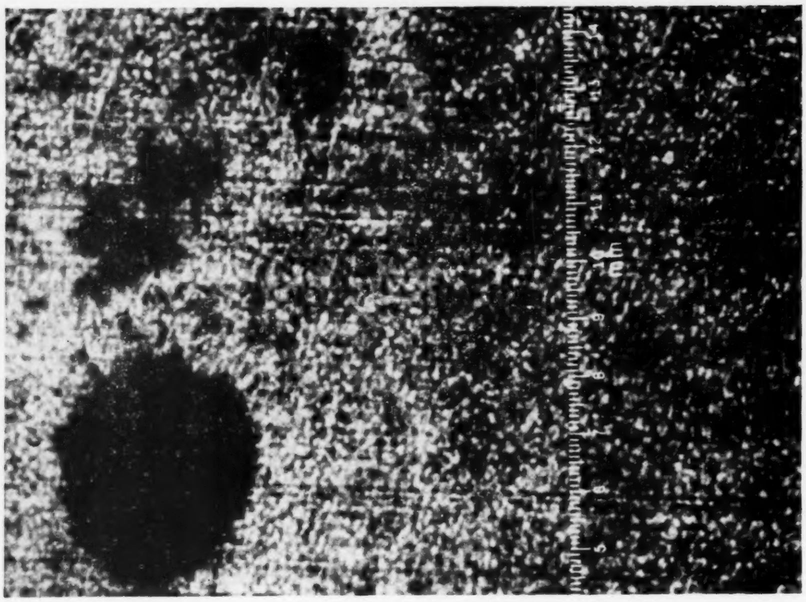
The observational results of this work consist of a series of measurements of the Doppler displacements, in kilometers per second, made along the wavy spectral lines at regular intervals of 0.1 millimeter, corresponding to 328 kilometers on the surface of the sun. The individual motions in the line of sight — corresponding to radial updrafts and downdrafts in the solar atmosphere — are distributed at random, with an average



In this explanatory diagram, solar lines marked 1 correspond to those labeled for iron below; telluric lines marked 2 correspond to those labeled "Atm."



The spectrum of the solar granules, photographed with the 150-foot Mount Wilson tower telescope by Richardson and Schwarzschild. The usual absorption lines are vertical, but appear bright on this negative print. The light and dark bands horizontally are due to granules, which produce irregular Doppler shifts only in the solar absorption lines, such as those of iron, labeled "FeI." Engraving, courtesy "Astrophysical Journal," University of Chicago Press.



The granulation of the sun's surface, photographed with the Yerkes 40-inch refractor by P. C. Keenan. Compare details here with the back-cover pictures. Yerkes Observatory photograph.

value of about 0.4 kilometer per second, either up or down. It was noticed that the more conspicuous black streaks on the negative spectrum plate, which correspond to the granular "rice grains," usually indicate an updraft in the solar atmosphere; otherwise the correlation between brightness on the solar surface and radial motion was rather weak. The precision of the measurements was very great, as is shown by the probable error of plus or minus 0.035 kilometer per second. It is a tribute to the splendid equipment of the 150-foot solar tower at Mount Wilson as well as to the ingenious method used by the authors, which involved for comparison the use of atmospheric lines produced by water vapor and other gases in our own air.

The most interesting part of this paper deals with the interpretation of the measurements. The authors attribute the motions of the granules to a state of turbulence in the atmosphere of the sun, which had long been suspected, but concerning which we know very little.

The concept of turbulence originated in aerodynamics, and is concerned with the manner of flow observed in liquids and gases. If the flow is smooth and orderly we call it laminar; if it is irregular and full of eddies of different sizes we call it turbulent. As a rule, the flow is laminar if the velocity of the stream is small and if its cross-section is moderate. The flow is more likely to be turbulent if the viscosity of the substance is large. Consider, for example, the flow of air over the heated surface of an electric plate — not a bad analogy to the solar problem. The flow may be either laminar or turbulent. To distinguish which case will occur we compute a quantity called the Reynolds number, which is given by an expression of Th. v. Karman,

$$R = \frac{3\ v\ D}{w\ \triangle},$$

where v and w are the velocities of the stream as a whole and of the individual particles within it which produce its viscosity; D is the cross-section of the stream, in our case roughly the height of the solar atmosphere; and $\triangle$ is the mean free path of the viscous particles. If R is greater than about 1,000 the flow is usually turbulent. The ratio v/w does not vary greatly. In the solar atmosphere it may be of the order of 10. But the ratio of $D/\triangle$ is very large, because the thickness of the reversing layer is very much greater than the mean free path of the atoms and molecules. Hence, the flow must be turbulent, and eddies are being formed.

These eddies consume energy. They form, break into smaller eddies, and finally dissolve within the gas. In doing so they ultimately convert their energies of motion into the thermal motions of the atoms and molecules: The temperature of the gas rises at the expense of the up-and-down draft. It is clear that this energy must be supplied from some source, just as the eddies in a current of air over a hot stove derive their energies from the heat of the stove.

According to A. Unsöld, this source of energy in the sun is provided by the ionization of hydrogen in a layer which lies a short distance below the photosphere, where the opacity of the solar gases becomes so great that we cannot see through. In the thinner gas above the photosphere the temperature is too low for the hydrogen atoms to become effectively ionized. But with increasing depth the temperature rapidly rises, and soon reaches a value of between 10,000° and 100,000° C., where the photons, atoms, and electrons possess enough energy to disrupt any neutral hydrogen atoms as soon as they form through the recombination of protons and electrons.

Unsöld was able to show that this phenomenon has an important consequence: The temperature within the hydrogen ionization zone rises more rapidly with depth than it would do in a quiescent layer undisturbed by ionization. We can picture this in the following manner. The flow of radiant energy from the internal nuclear source of the sun, through the ionization zone, must supply the energy required to ionize the neutral hydrogen atoms, thus increasing its own "gradient." But it was already known that when the temperature gradient through an atmosphere is greater than the normal gradient (called adiabatic), a volume of gas which for some reason begins to rise finds itself, after a short interval of time, with a higher temperature than that of its new, cooler surroundings, and is therefore still further impelled to rise. The result is convection within the gas, consisting of large-scale motions in the ionization zone. H. Siedentopf suggested that the granules of the solar surface are actually the individual turbulence elements rising from the convection zone below the photosphere, and this view has been further elaborated in papers by A. S. Eddington, M. Schwarzschild, and others.

The elementary theory of turbulence defines a quantity called the mixing length, that is, the distance over which a turbulent eddy exists as an individual entity. The lifetime of an eddy must be the mixing length divided by the velocity of the eddy. Early estimates of this velocity were of the order of three kilometers per second; the mixing length, roughly equal to the diameter of a granule, is 1,000 kilometers. Hence, each granule should last for an interval of 1,000/3 seconds, or about five minutes. This rough estimate is consistent with observed lifetimes of the granules.

But, according to the new results by Richardson and Schwarzschild, the turbulent velocities of the granules are really about eight times smaller, and the question arises how we should reconcile their measurements with the theory of turbulence.

The answer is that the state of turbulence of a gas cannot be well described by turbulent eddies of one size. Laboratory experiments have shown that there are many different sizes of eddies, some being as large as the thickness of the layer, while others are smaller, the smallest possible size being given by the requirement that for them the Reynolds

number becomes smaller than 1,000. Inside of such small eddies conditions no longer favor turbulent motions and they do not break up into still smaller eddies, but dissipate into the amorphous mass of gas of the surroundings.

In a turbulent gas there is one particular size of eddies that have the greatest velocities. Larger eddies have much smaller velocities. Eddies that are smaller than the most favorable size also move with smaller velocities. The relation between the average speed of eddies and their sizes is called the *spectrum of turbulence* and its theory has been worked out in recent years by Kolmogoroff, Heisenberg, Chandrasekhar, and others.*

Richardson and Schwarzschild believe that the slow motions of the granules which they have observed refer to turbulent eddies considerably greater than the most favorable size. They call attention to the fact that the Fraunhofer absorption lines of the sun are broader than those produced by a quiescent gas at the temperature of the solar reversing layer. This broadening can be explained by assuming that there are small eddies, too small to be detected in the direct photographs, whose velocities are of the order of two or three kilometers a second. This seems to be a direct confirmation of the existence of a spectrum of turbulence in the atmosphere of the sun.

According to these investigators, the most favorable diameter of the eddies is about 100 to 200 kilometers, and the corresponding velocities are about three kilometers per second. Such eddies, if they really exist, should be much brighter, and bluer, than the granules which have thus far been detected. They may be 400° C. hotter than the intergranular spaces. Their angular diameters should be about 0.2 second of arc. Such a high degree of resolution has not thus far been obtained in solar observations, but it is not impossible that with a large telescope, and under favorable conditions of seeing, the small-scale granulation predicted by Richardson and Schwarzschild can be detected.

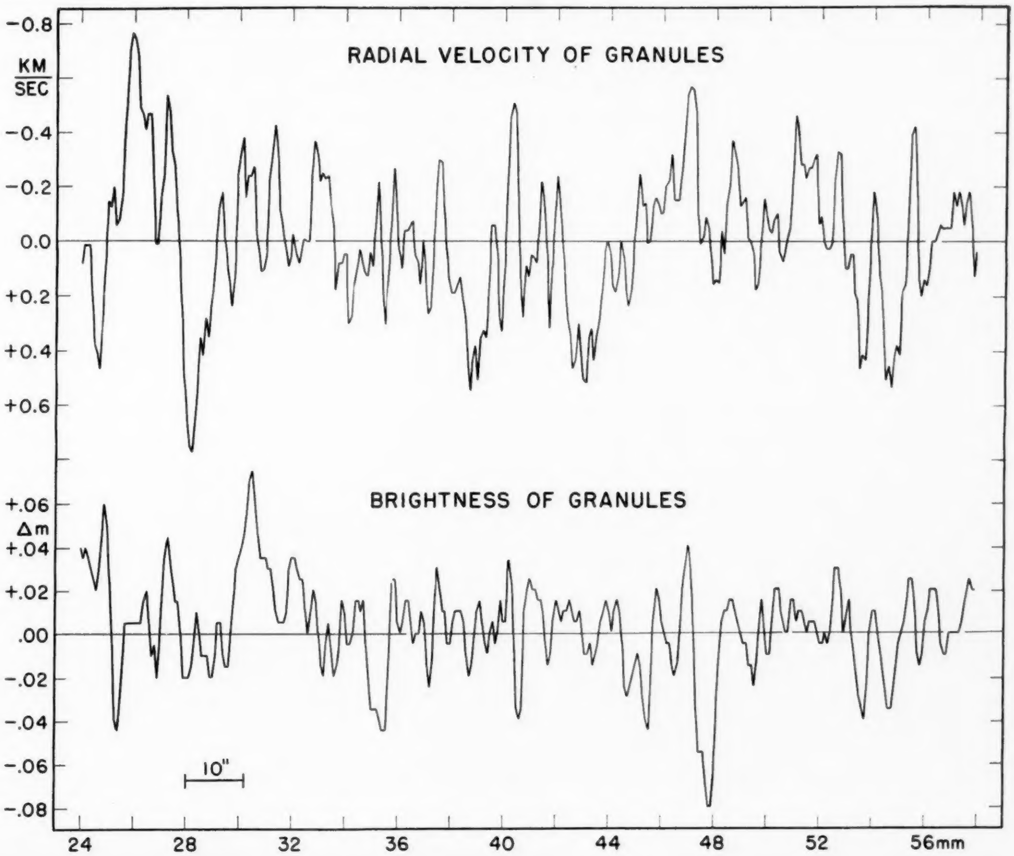
As a matter of fact, most solar instruments employ comparatively small-aperture objectives. For example, one of the direct photographs used by Richardson and Schwarzschild for measuring the brightnesses of the granules was obtained with the objective of the 60-foot Mount Wilson tower telescope diaphragmed to four inches. As they point out, the resolving power of so small an aperture is about one second of arc. It would require an aperture of about 40 inches (like that of the Yerkes refractor) to detect the small granules predicted in this work.

Some 10 or 15 years ago there was a serious controversy among astronomers as to the real size of the solar granules. The early work of Janssen in France and of Hansky in Russia had given values of the order of one to two seconds of arc, but more recent photographs by H. H. Plaskett at Oxford and by ten Bruggencate and others in Germany gave values of the order of five seconds of arc. The work of P. C. Keenan, whose best photograph, taken July 10, 1937, is reproduced here, clearly demonstrated that the larger value referred not to single granules, but to clusters of granules.

The question arises, are the small granules measured by all modern workers complete individual eddies, or do they, too, represent statistical combinations of much smaller elements. Another question is whether the exceedingly difficult technique at the spectrograph has introduced any appreciable smearing through poor seeing, irregularities in the guiding, and optical imperfections in the instrument. But the available evidence suggests that these sources of error are far too small to explain the remarkable fact that the motions of the granules are so small.

An important question which has not been fully answered is whether the motions of the granules are mainly in the nature of updrafts, or whether they are isotropic, that is, distributed at random in all directions. The authors adopt as the more probable hypothesis an isotropic distribution of velocities, but this point will undoubtedly be again discussed when more material is available.

*An account by S. Chandrasekhar of the theoretical developments appeared in his Russell lecture, *Astrophysical Journal*, *110*, 329, 1949; condensed in *Sky and Telescope*, *VIII*, 279, 1949. A more general summary of "Turbulence and its Significance in Astrophysics," by J. Meurers, was printed in *Die Himmelswelt*, *56*, 156, 1949.



Microphotometer measurements of Doppler displacements of the solar granules may here be compared with the relative brightnesses of the same granules. The correlation of brightness and velocity is weak, except that narrow regions of high upward (negative) velocity appear to be brighter than the average. Engraving courtesy "Astrophysical Journal."

Amateur Astronomers

Amateurs in Central States Meet at Kansas City

MID-STATES amateurs held a successful convention at the Kansas City Museum on the 17th and 18th of June. Sixty-five delegates registered from Kansas, Missouri, and Texas. Representatives from the St. Louis Amateur Astronomical Society, the Kansas City Amateur Astronomers and Telescope Makers, Central Missouri Amateur Astronomers, Wichita Amateur Astronomical Society, and the Topeka Amateur Astronomical Society, attended the two-day sessions. The address of welcome was given by Charles G. Wilder, director of the museum.

Stuart O'Byrne, of St. Louis, spoke on "Useful Observations of a Nova before Magnitude Sequences are Available," and the writer followed with "The Amateur Astronomer and Useful Observational Work." "Celestial Photography for the Amateur" was discussed by Earl Bess, of St. Louis. L. E. Hockett, McPherson, Kans., presented, "Building a Good Equatorial Mounting." Mr. O'Byrne showed Kodachrome slides taken at the Arizona Meteor Crater, and Flagstaff Observatory. E. A. Neal, curator of education at the museum, discussed the museum's program of astronomical education for the public and in the schools. This was followed by "The Enigma of the Asteroids," by Edward Bowman, of Kansas City, and a paper written by Walter Haas on the Association of Lunar and Planetary Observers.

Following the papers, the amateurs held an informal get-acquainted session as they examined the exhibits of books, charts, photos, and nine telescopes. Later the delegates reassembled at the Melrose Methodist Church for their banquet, and a talk, "The Time-Scale of the Universe," by Dr. N. W. Storer, professor of astronomy at the University of Kansas.

The evening session began at 7:30 with demonstration lectures at the Spitz planetarium in the museum. This was followed by an enthusiastic star party on the museum lawn which lasted well past midnight.

For next year's Mid-States convention, the delegates accepted an invitation from Dr. Floyd Helton, director of the Morrison Observatory, Central College, to meet at Fayette, Mo. It was proposed that a new region of central states be formed in the Astronomical League, and action is being taken on this proposal.

At the Sunday morning session a fine film was shown on the building of Mr. Bowman's 24-inch reflector. Reports from societies and a conducted tour of the museum concluded the convention.

I am sure the delegates left for their homes with a good feeling that something definite has been accomplished for stimulating greater activity in amateur astronomy in this area.

RUSSELL C. MAAG
611 Bluff St., Fulton, Mo.

ASTRONOMICAL LEAGUE NOTES

During the Wellesley convention of the Astronomical League, it was announced that applications for membership had been received from two societies: Fort Worth Astronomical Society, Ft. Worth, Tex.; and the Astronomy Section of the Rochester Academy of Science, Rochester, N. Y.

Establishment of the proposed region of central states was authorized by the league council.

Consideration of the site for the general convention in 1951 included the possibility of arranging for dates on Labor Day weekend inasmuch as July 4th comes on a Wednesday next year. A prime factor in the discussion was the annular eclipse of the sun that will occur at sunrise or shortly thereafter on September 1, 1951, for observers in northern North Carolina and southern Virginia. The path of "annularity" starts in the Appalachian Mountains and extends eastward over the ocean to the Eastern Hemisphere. Norfolk, Va., lies nearly at the center of the path, and Chapel Hill, N. C., near its southern edge.

THIS MONTH'S MEETINGS

Chicago, Ill.: The Burnham Astronomical Society will hold its 10th annual observation party at the home of Mr. and Mrs. H. C. Torreyson, Mount Prospect, Ill., on Saturday, August 19th.

Dallas, Tex.: Christine Westgate, formerly with Yerkes Observatory, and Mrs. E. B. Willis, of La Jolla, Calif., will be the speakers at the August 28th meeting of the Texas Astronomical Society, 8:00 p.m. at the Dallas Power and Light auditorium. Miss Westgate will speak on the "Colors of the Stars," and Mrs. Willis on "Palomar" and "Oceanography."

Geneva, Ill.: The Fox Valley Astronomical Society is planning observations of the Perseid meteor shower for the night of August 12th, Saturday.

Indianapolis, Ind.: On August 6th, Walter Wilkins will speak about "Our Milky Way" at the meeting of the Indiana Astronomical Society which will be held at the Goethe Link Observatory, in Brooklyn, Ind.

Kalamazoo, Mich.: The Kalamazoo Amateur Astronomical Association will meet at the home of Thomas Todd, 3371 W. Main St., on August 12th at 8 p.m. "The Sun" will be discussed by William Persons.

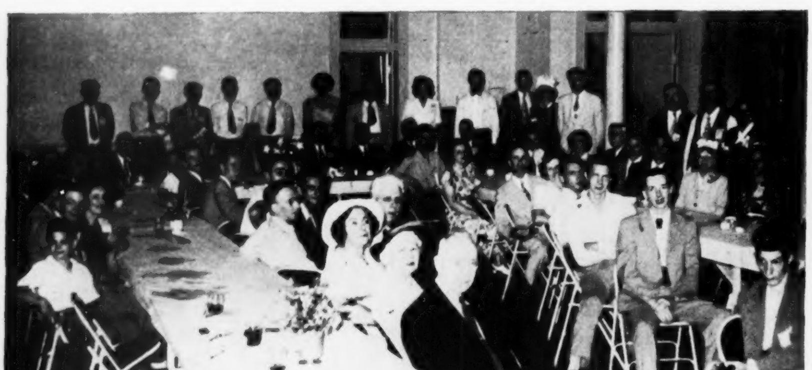
Los Angeles, Calif.: Dr. R. S. Richardson, of Mount Wilson Observatory, will talk on "Theories on the Origin of Sunspots" at the meeting of the Los Angeles Astronomical Society, 7:45 p.m. at the Griffith Observatory.

Palo Alto, Calif.: The second conference of western amateur astronomers will convene on the Stanford University campus, August 14-16.

SEPTEMBER TOTAL ECLIPSE

A total eclipse of the sun will sweep from the polar regions across Siberia and to the central north Pacific on September 12th. The path of totality is nearly north-south for most of its way, extending from near the north pole to latitude about 35° north. It is in the Eastern Hemisphere most of the time, but begins and ends in the Western Hemisphere.

Attu and Agattu islands, at the tip of the Aleutian chain, lie in the path of totality where the eclipse has its maximum duration, nearly one minute and 14 seconds. At the Hawaiian Islands, a partial eclipse will be seen beginning while the sun is setting. Partial phases will be visible in Asiatic Russia and Japan; and at Anchorage, Fairbanks, and Nome, Alaska, more than 80 per cent of the sun's diameter will be obscured by the moon.



The banquet at the Mid-States amateur convention at Kansas City, Mo., was attended by 78 persons.

Symposium on the Galaxy

The front-cover picture includes the 11 astronomers who participated in a symposium on the structure of the galaxy, reported here. The occasion was the dedication of the Heber Doust Curtis memorial telescope of the University of Michigan.

THE DEDICATION of a new Schmidt camera and a symposium on the structure of the galaxy brought astronomers from all parts of the country to Ann Arbor, Mich., June 22-24. The 24-36-inch Schmidt, now operating at the University of Michigan's new Portage Lake Observatory, was dedicated to the memory of the late Heber D. Curtis.

More than 30 years ago, Dr. Curtis was among the first to adhere to the belief that the nebulous "island universes" investigated by Herschel lay outside our own galaxy, although the majority of astronomers pictured a larger, more inclusive Milky Way system. It was therefore appropriate for the symposium of 11 leading astronomers (see the front cover) to discuss questions of galactic structure.

Inasmuch as opaque dust clouds interfere with our view of the center of the Milky Way system, the 200-inch telescope has begun the investigation of other galaxies to give us greater understanding of our own system. Dr. Walter Baade, of Mount Wilson and Palomar Observatories, described problems of galaxies in an evening lecture on June 22nd, and discussed more detailed points in the first paper of the symposium.

The neighboring spirals, Messier 31 in Andromeda and Messier 33 in Triangulum, are believed to be similar to our own, but the analogies are not all simple. With the 200-inch instrument and blue-sensitive plates, Dr. Baade expected to resolve into stars the nucleus of the Andromeda galaxy, as had already been done for this and its smaller companions with red-sensitive plates and the 100-inch Mount Wilson reflector. The brightest stars of the nuclei of galaxies are red giants; the brightest blue stars in M31 were expected to be of apparent magnitude 22.2, but recent long-exposure 200-inch photographs reaching 22.7 failed to show any resolution of the nucleus of M31, nor were its companions, M32 and NGC 205, resolved.

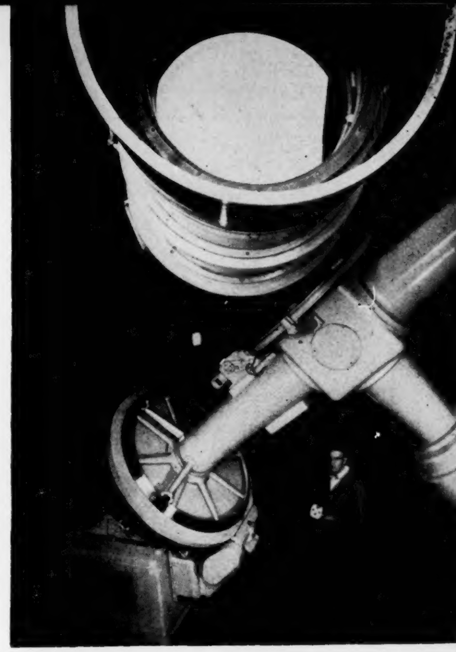
On the positive side, however, with two-hour exposures Dr. Baade for the first time has resolved into stars the outer portions of three globular clusters associated with M31. The present estimated distance of up to 800,000 light-years for this galaxy is based on observations of classical Cepheid variable stars in the arms of the system. Now it should be possible to determine the distance by means of the cluster-type variables in the globular clusters, as is done in our own Milky Way system.

The brightest Andromeda globulars seem to be about a magnitude fainter in total luminosity than Milky Way globulars, −8 absolute magnitude instead of −9. But there is a recognized discrepancy in the zero point of the period-luminosity curve of classical Cepheids as compared with cluster-type variables, and observations of the Andromeda globulars may clear up this problem.

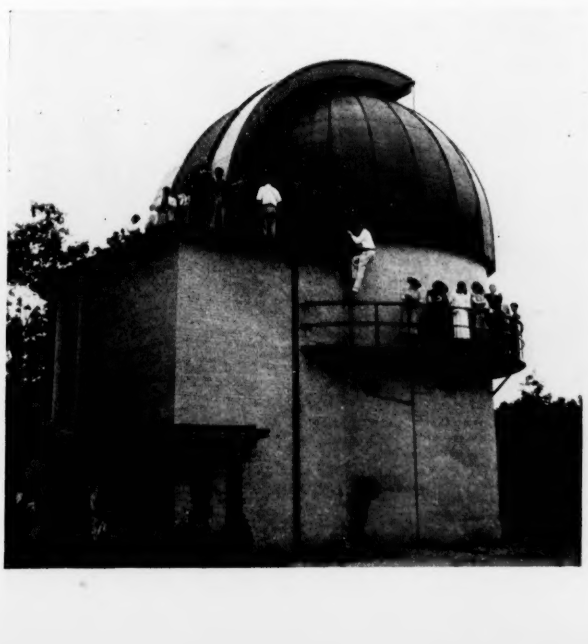
Dr. N. U. Mayall, of Lick Observatory, University of California, proposed further analogies after studying the rotational motions of M31 and M33. (See *Sky and Telescope*, November, 1948.) He reported that from spectrographic observations of radial velocities of bright-line emission objects in M31, the points of maximum rotational velocity have been located. They lie at an angular distance of about 70 minutes of arc from the nucleus, at each end of the spiral. As in M33, indications are that farther out the velocities are less (as with the planets of the solar system); several outlying bright-line objects show periods from 90 to 200 million years.

In what Dr. Mayall called a "first crude attempt" to locate the analogous region of maximum rotation in the Milky Way, he has analyzed radial velocities of some 150 Cepheid variable stars determined by Dr. A. H. Joy at Mount Wilson. The maximum rotational velocity probably occurs at a distance from the center of the order of 9/10 that of the sun; this maximum velocity appears to be only a few per cent greater than that at the sun's distance. The speed of the sun itself may be considered as being between 180 and 280 kilometers per second, depending on the values used for its distance from the center — 6,000 to 9,000 parsecs.

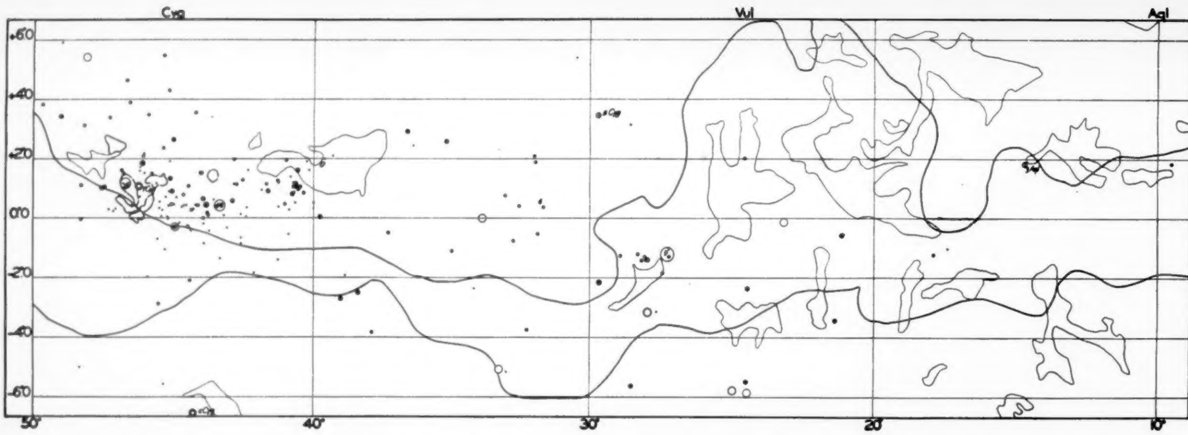
A systematic search of the Milky Way system was reported on by Dr. R. Minkowski, of Mount Wilson and Palomar. The search has revealed 212 new planetary nebulae, bringing the known total to 371. Of these, 295 are in the strip between galactic latitudes +10° and −10°, indicating a moderate concentration toward the galactic plane. There is a high concentration toward the



A view down the tube of the Curtis telescope, through the 24-inch correcting plate to the 36-inch primary mirror. The effective focal ratio is f/3.5, and the instrument is a duplicate of the Schmidt camera of the Warner and Swasey Observatory in East Cleveland, Ohio. Photograph by University of Michigan News Service.



After the dedication ceremonies in Ann Arbor on July 24th, a general inspection of the Portage Lake Observatory took place. Visitors were allowed on the roof of the Curtis telescope building for a better view of the instrument. See the February, 1950, issue of "Sky and Telescope" for a description of the Portage Lake Observatory.



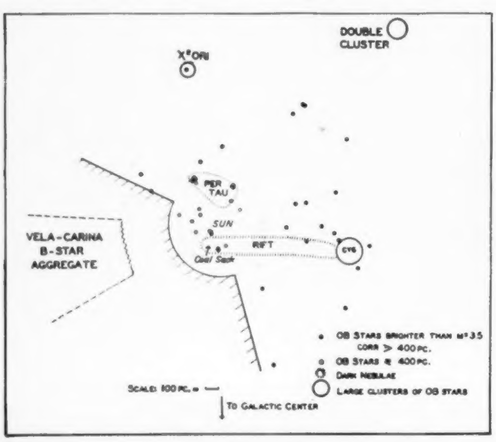
A reproduction of a portion of a 29-foot chart along the galactic equator 12 degrees wide. This part extends from 10° to 50° in galactic longitude, from Aquila to Cygnus. The two continuous lines show the boundaries of the great rift. Other areas of diffuse and dark nebulae, and galactic clusters are marked as in the Skalnate Pleso "Atlas of the Heavens." The dots represent early-type stars of high luminosity. Their sizes indicate apparent visual magnitudes, ranging from about 6.0 to 10.0, largest to smallest. Some 200 OB stars are found between longitudes 40° and 50°, the area of the greatest concentration in the Nassau-Morgan survey. In spite of the fact that the region between 10° and 30° longitude and south of −2° latitude is known to be relatively unobscured, there are only six observed OB stars. Chart from Warner and Swasey Observatory.

galactic center, and in this direction the mean apparent size of the planetaries is the least, 5.9 seconds of arc. This supports the conclusion that the bulk of the planetaries observed in this direction is actually a distant group at the center of the galaxy.

For the practical problem of classifying objective-prism spectra, Dr. W. W. Morgan, of Yerkes and McDonald Observatories, described "natural groups" for dispersions ranging from 1,500 to 200 angstroms per millimeter in the neighborhood of the hydrogen-gamma line. He gave an approximate calibration in terms of absolute magnitude, together with a description of the applicability of each spectroscopic group to problems of galactic structure.

One of these groups, called type *OB*, includes blue and blue-white stars of high surface temperature and great intrinsic brilliance, all at least 1,500 times as bright as the sun and many over 10,000 times as bright. Dr. J. J. Nassau, of Warner and Swasey Observatory, Case Institute of Technology, presented a report jointly with Dr. Morgan on a survey for *OB* stars that began two years ago with the support of the Office of Naval Research. Over 400 plates covering a belt 12 degrees wide from Sagittarius to Canis Major have been taken with a 4-degree prism in front of the correcting plate of the Warner and Swasey Schmidt telescope, of which the new Michigan instrument is a duplicate.

The search yielded over 900 *OB* stars, but for the majority of them the distances are undetermined. However, for 49 relatively nearby *OB* stars and for three groups shown on the diagram below, Dr. Morgan has collected the required data. Combining the results with already existing knowledge of many facts about the galaxy and other galaxies, these astronomers suggested that the sun is located near the outer border of a spiral arm. The arm extends roughly from the constellation Carina to Cygnus. The fact that many faint and hence distant *OB* stars are found toward Cygnus indicates that we are observing the stars in the extension of this arm beyond the clustering in that constellation, that is, beyond 3,000 light-years.



A plot in the galactic plane of 49 OB stars and three clusterings of OB stars in the neighborhood of the sun. The blocked-off area to the left and below the sun is the region of the sky inaccessible in mid-northern latitudes. A spiral arm is suggested as extending roughly from Vela-Carina to Cygnus. Diagram from Warner and Swasey Observatory.

The part of the spiral arm near our sun contains a large cloud, or groups of small clouds, of interstellar dust and gas which obscures the distant stars and divides the Milky Way into two branches, easily visible to the unaided eye. This obscuring cloud or rift is in the shape of a slightly bent cigar and is over 3,500 light-years long. At one end of it is the southern Coalsack and at the other the brilliant group of *OB* stars of the Northern Cross.

Clusterings of the bright *OB* stars in Cepheus, Cassiopeia, Gemini, Monoceros, and Canis Major, may indicate another spiral arm outside the one in which the sun is located. Dr. Nassau cautioned, however, that the evidence is insufficient at present to preclude the hypothesis that a great disorganization exists in the galaxy and that the star groupings do not trace definite spiral arms.

Not all studies of the Milky Way are confined to regions near the galactic equator, where the hazards introduced by the patchy absorption are most numerous. Dr. Freeman D. Miller, of the University of Michigan, pointed out that because of the unknown effects of interstellar absorption at large distances near the galactic plane, counts of faint stars at intermediate latitudes are less uncertain than those near the plane. For instance, he has carried on a program of faint star counts (limiting magnitude about 17.5) at galactic latitude −30° in the Pegasus-Andromeda region. At such a latitude, galaxies are normally visible in sufficient numbers on Schmidt plates for statistical analysis and evaluation of total interstellar absorption, as indicated by Mount Wilson and Harvard galaxy counts. General star counts made on plates taken as part of a program with Harvard's Jewett Schmidt were discussed by Dr. Miller.

The motions of 430 giant red-orange *K* stars and 425 blue-white *A* stars (of about the same average individual mass as the giant *K* stars), all within 325 light-years of the sun, were examined by Dr. A. N. Vyssotsky, of the Leander McCormick Observatory at the University of Virginia. The motions were divided into three components, two in the galactic plane and one at right angles to it. In general, it has been known that the dispersion of motions is very much greater among *K* giants than among the *A* stars, particularly in the direction of the galactic poles. However, by grouping the *K* giants according to the inclination of their motions to the galactic plane, those with the smaller inclinations of their orbits around the galactic center are found to move in a fashion very similar to that of the *A* stars.

On the assumption that the stars in our vicinity are moving in orbits according to Kepler's laws, the deviations for these nearby *A* and low-inclination *K* stars are interpreted by Dr. Vyssotsky as an indication of local structure similar to a spiral arm — the rotation should be in the sense that the arms are trailing.

The detailed structure of 12 Milky Way regions is under investigation at the Warner and Swasey Observatory. Dr. Sidney W. McCuskey reported that 17,000 spectral observations have been made, and the space densities have been calculated for seven of the regions. A high density to 2,000 parsecs was found at galactic longitude 70°. In regions at 133° and 165° a space population 2½ times that in the solar neighborhood was evident at 1,500 to 2,000 parsecs.

When compared with the theory of a steady state of motion in the galaxy, the observed velocity distribution shows certain deviations, such as differences in the directions of motion of certain types of stars, for instance, the cases studied by Dr. Vyssotsky. Dr. Bertil Lindblad, director of Stockholm Observatory and president of the International Astronomical Union, discussed a theory of the development of spiral structure based on the existence of a "bar." Such a bar is apparent as an increased density along a certain diameter of the galaxy, and once it exists, Dr. Lindblad believes its disturbing action may produce the spiral structure that is so often associated with other galaxies that are classed as barred spirals. The differences in velocity distribution in our own galaxy may result from the presence of such a bar.

The discovery of more hydrogen emission objects in the Magellanic Clouds was announced by Dr. Karl G. Henize, of Michigan's Lamont-Hussey Observatory in South Africa. He reported about 160 new objects stellar in appearance and about 110 nebulous ones in the Large Cloud, and approximately 90 stellar objects and 30 nebulous ones in the Small Cloud. This work may shed further light on the extent and space distribution of the Magellanic Clouds.

Dr. Harlow Shapley, director of Harvard College Observatory, was chairman of the symposium. He concluded the sessions by discussing the relation of the Magellanic Clouds to our galaxy. The distances of the clouds from the sun and from the galactic nucleus are practically identical (about 80,000 light-years), and they are near enough to the galactic plane to be located within the outermost part of the spheroidal star haze that surrounds the Milky Way system. The clouds seem to be neither approaching nor receding from the galaxy.

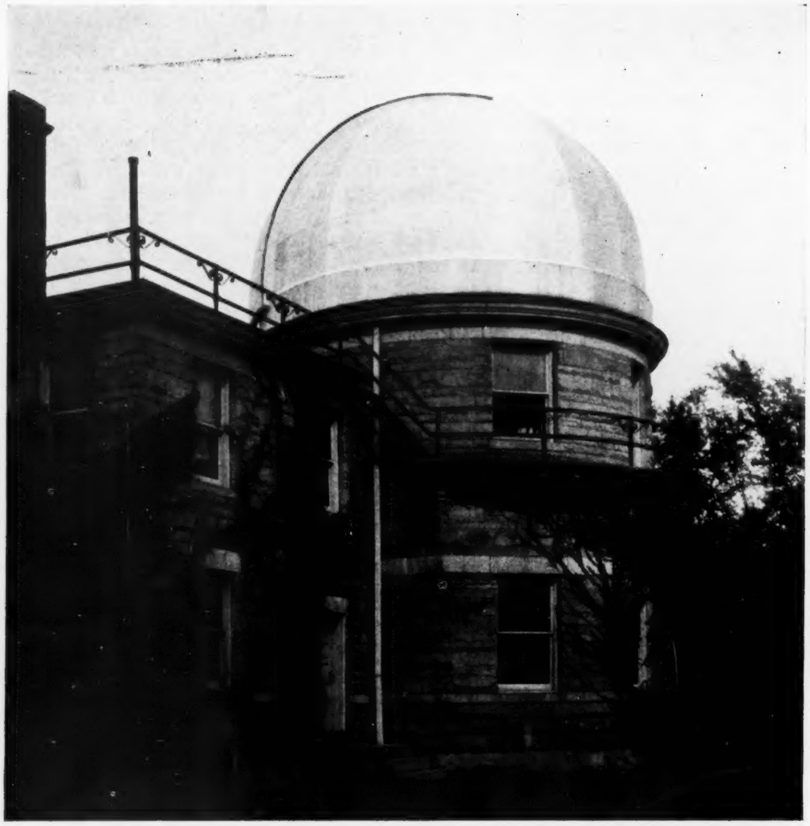
The total photographic absolute magnitude of our galaxy is perhaps −18; values of −16.2 for the Large Cloud and −14.5 for the Small Cloud are more reliable. The masses of the clouds should therefore be about 18 per cent

(Continued on page 255)

The Large and Small Magellanic Clouds. The Large Cloud (at the left) is in the constellation Doradus; the Small Cloud is in Tucana. Close to the right-hand edge is Beta Hydri; Gamma Hydri, a red star, is inconspicuous near the center of the field. Harvard Observatory photograph.

AMERICAN A

Here are highlights of some pap pre
at Bloomington, Indiana, in J.



Kirkwood Observatory of the University of Indiana, at Bloomington, where the American Astronomical Society met June 18-21, was built 50 years ago.

Collisions of Galaxies

SOME YEARS AGO it was found that galaxies occurring in dense clusters were systematically different in nature from isolated galaxies. If the latter are shaped like flat disks, as is our own Milky Way, they almost always contain gases and tiny solid particles drifting about between the stars. This interstellar matter is believed to produce new stars, some of which shine enormously brighter than the other stars and burn themselves out in about a hundred million years. Within compact clusters of several thousand galaxies, however, practically none of the flattened galaxies observed have any appreciable amount of interstellar matter, no obscuring clouds are seen, and the very luminous relatively "young" stars do not exist.

Dr. Lyman Spitzer, Jr., director of Princeton University Observatory, and Dr. Walter Baade, of Mount Wilson and Palomar Observatories, suggest that this lack of interstellar matter in cluster galaxies is a direct result of collisions between galaxies. When two such systems collide with each other, the stars are so far apart in relation to their sizes that virtually no direct collisions between stars will occur, and the two stellar systems will each pass freely through the other, emerging relatively undisturbed on the other side. Two systems of 100 million stars each can collide and have only one or two actual stellar collisions.

Interstellar matter with a density as great as 0.1 hydrogen atom per cubic centimeter, however, will not be able to interpenetrate another mass of similar gas and dust and a "catastrophic collision" will result. The gases will be heated to a temperature of many millions of degrees, to be completely swept out of both galaxies. As the latter separate, the interstellar matter will all be left in an expanding cloud between the galaxies.

In such a typical dense cluster as the Coma cluster, each galaxy will collide with at least 25 others during the roughly three billion years since all the galaxies were presumably formed, assuming the galactic motions within the cluster to be primarily radial. Galaxies like our own, which are not in compact clusters, have had few, if any, collisions and have been able to retain their interstellar matter.

Nova Clues

AT THE TIME of outburst of a nova, a shell of gas is blown out in all directions around the star. This principal shell continues to expand for years afterward, with undiminished speed. Other clouds of gas are erupted continuously or intermittently for some days or even weeks after the main outburst. These give conspicuous spectra

Members and guests of the American Astronomical iety,

N Astronomers Report

me pap presented at the 83rd meeting of the American Astronomical Society
, in J . Complete abstracts will appear in the Astronomical Journal.

known as the diffuse enhanced and Orion absorption systems. Nova Lacertae 1950, which reached maximum in late January, had the full complement of erupted clouds. Its principal shell apparently had two parts: an inner layer moving about 600 miles per second, and an outer layer moving at 750 miles per second. Dr. Dean B. McLaughlin, of the University of Michigan Observatory, described and interpreted the observed changes in spectrum.

As in some other novae, the light varied irregularly during the decline from maximum. At the subordinate maxima the spectrum indicates lower temperature, probably because each maximum is due to a newly ejected cloud which absorbs much of the star's radiation in the far ultraviolet but reradiates the energy in visible light. At the minima of light the spectrum indicates higher temperature, because the cloud close about the star has cleared away, permitting the hot star to shine through. Nova Lacertae went through changes of this type that were strikingly reminiscent of the behavior of Nova Geminorum 1912.

Some novae have shown considerable changes of the speed of the outward-rushing gases. The interpretation is uncertain. Increase of speed can be blamed on the pressure of radiation of the star. Decrease of speed is harder to understand, for gravitation should be unable to slow down the gases as much as the observed amount, unless novae are stars with simply unbelievable masses.

Nova Lacertae 1950 furnishes some evidence which, though not conclusive, strongly suggests an interpretation of some changes of speed. About a month after the main maximum of light, the faster-moving part of the principal shell gave the stronger lines. Then the star brightened, and immediately the lines of the fast-moving gas weakened and those of the slower-moving gas became the stronger. When the star faded, the faster-moving gas again gave the stronger spectrum. Other features of the spectrum showed that the brightening of the star, as usual, corresponded to a lowering of temperature.

Dr. McLaughlin offered the following suggested explanation. The star was so hot that the inner layer of gas (the slow-moving layer) was mostly ionized and unable to give its customary spectrum lines. When the star brightened and cooled, the ionized atoms recombined with electrons and were then able to absorb their characteristic wave lengths of light. At the same time, this inner shell shielded the outer one from the star's radiation, so that not many atoms in the outer layer were in the excited state and able to absorb lines; hence the spectrum of the fast-moving shell weakened. When the light faded (as the newly ejected cloud about the star cleared away), the hot star shone through again and ionized the inner layer, so that its lines again weakened.

Possibly this explanation can be generalized to account for many other apparent changes of speed of gas shells about novae. If this interpretation is correct, it means that novae are probably no more massive than the general run of stars, Dr. McLaughlin concluded.

S-type Stars

OF ALL the well-known groups of stars which are recognized by the appearance of their spectra, those of type *S* are the only ones that have never been classified in a temperature sequence. These are the stars which have spectra characterized by bands of zirconium oxide. They show also bands of lanthanum oxide and other heavy oxides, and the titanium oxide bands familiar in stars of type *M* are often present. It is this complexity of band structure, together with the faintness and redness of most of the stars of this small group, which had made it so difficult to classify their spectra.

Dr. P. C. Keenan, of Perkins Observatory, Ohio State and Ohio Wesleyan universities, proposed a new classification of the *S* stars using the strength of the most conspicuous bands to arrange

omical Society, at its 83rd meeting, June 18-21. Photograph by Audio-visual Center, Indiana University.

the stars in order of temperature. This is done by taking the sum of the intensities of the bands of zirconium oxide and titanium oxide as the criterion of classification. The sequence set up in this way runs from *S*0 to *S*9 in order of decreasing temperature and closely parallels the sequence of ordinary *M*-type stars. Subscripts are used by Dr. Keenan to preserve useful characteristics of previous classifications. He pointed out that the next step needed is a measurement of the actual temperatures corresponding to these new spectral classes. From the spectra and colors it can be roughly estimated that they lie in the range from 4,000° to 2,000° absolute.

Origin of the Taurids

FROM October 14th to November 30th the earth runs into meteors that have orbits related to that of Comet Encke. At Harvard Observatory, Dr. Fred L. Whipple and Dr. Salah El-Din Hamid find that the orbit planes of four doubly-photographed Taurid meteors coincided reasonably well with that of the comet at an average date 4,700 years ago. Three other orbit planes coincided roughly with each other, but not with that of Comet Encke, at a time some 1,500 years ago. Furthermore, the orbits of each set tend to cross, near a distance from the sun of three astronomical units and before aphelion for those 4,700 years ago, and near aphelion for those 1,500 years ago.

Drs. Whipple and Hamid suggest that the Taurid streams were formed chiefly by a violent ejection of material from Encke's comet some 4,700 years ago, and also by another ejection some 1,500 years ago from a body moving in an orbit of similar shape, possibly a component of Comet Encke that split away at an unknown time in the past.

It was proposed tentatively that these violent ejections were the result of encounters with small asteroidal bodies, since the suggested points of ejection lie near the plane of the asteroids and the earlier one near the region of their greatest concentration. The proposal must be tested further, however, for various reasons including the possibility that the orbit of Encke's comet may have changed erratically in the past.

Colors in Cygnus

TO OBTAIN a broader picture of the shape of the galaxy, the stars which lie on both sides of the central plane of the Milky Way are being studied by Dr. Donald A. MacRae, on objective-prism plates taken with the Schmidt telescope of the Warner and Swasey Observatory. A field in Cygnus 14 degrees from the plane of the galaxy on the north side has been chosen as the first step in this program.

The interstellar absorption in this direction can be found from the excess reddening of the stars. Data on the colors of stars of each spectral type unaffected by interstellar absorption have been gathered from recent photoelectric measures of stars in the Pleiades, the Hyades, and some other groups of stars. As a by-product of this part of the work, it has been found that not all stars of a given spectral type have exactly the same color, but that there is a real variation of a few hundredths of a magnitude. Similarly, Dr. MacRae found that the intrinsic luminosities of dwarf stars of a given spectral type may vary by 3/10 of a magnitude about their mean value.

A comparison of the intrinsic colors with the observed colors in Cygnus shows that only a small amount of absorption is present there, the stars at 1,200 parsecs being dimmed by less than half a magnitude. Thus we have additional evidence that in these directions the Milky Way is remarkably free from obscuration.

TERMINOLOGY TALKS

J. HUGH PRUETT

"Apo" and "Peri"

In a previous Talk (October, 1948), the terms aphelion and perihelion were considered and found to be compounds of the Greek noun *helios* (sun) and the prepositions *apo* (away from) and *peri* (around). As used astronomically they usually indicate the positions of planets and comets on their elliptical orbits when farthest from and nearest to the sun.

The same prefixes are used in connection with other heavenly bodies. Apogee and perigee (pronounce g as j) are similar compounds of the prepositions with *gee* (earth) and mean "away from the earth" and "around the earth." They are used principally in connection with the moon to designate its greatest distance from and its closest approach to our world. Corresponding terms could be compounded regarding the positions of the satellites of any of the planets, but such are rather scarce in astronomical literature. Apojove and perijove, referring to the positions of the moons of Jupiter, can be found in some dictionaries.

Out among the binary double stars we may apply the terms apastron and periastron. Since *astron* means star, we naturally conclude that these words signify the positions "farthest from" and "nearest to" a star. The components of a binary star are gravitationally connected and revolve about their common center of mass in elliptical orbits. Their separations vary, and the terms mentioned signify the two extremes.

Conjunction

As viewed from our earth, the other planets make various apparent configurations among themselves and with the sun and moon. Very commonly found in almanacs is the word *conjunction.* This comes from the Latin meaning "to join together," or "to join with." We might naturally infer then that two heavenly bodies are in conjunction only when one passes over the other so they occupy practically the same place on the sky or when they appear to be fused together. The joining does not have to be nearly so complete as this. Loosely stated, it can mean the nearest seeming approach while passing each other. However, the very closest approach is often not the conjunction point — although usually nearly so.

Technically speaking, two celestial objects are in conjunction at the instant when they are at the same longitude or the same right ascension. Right ascension (explained in the Talk for April, 1948) is measured eastward along the celestial equator starting from the vernal equinox, the point where the equator and the ecliptic (the sun's annual path around the sky) cross. Celestial longitude is measured from this same point and in the same direction, but along the ecliptic instead of the equator. In the *American Ephemeris,* conjunction of the moon or a planet with the sun marks the instant they are at the same longitude with the sun. However, conjunction of the moon with a planet or of two planets with each other indicates that they are at the same right ascension.

One might assume there would be no difference in time in conjunctions in longitude and right ascension. Avoiding mathematics, all one has to do is to inspect a good astronomical globe. The ecliptic is inclined 23½° to the equator at their crossing and is parallel to it only at the solstices. But generally there will not be any great difference in time between the two types of conjunction.

Opposition

Opposition in some connections indicates hostility, but it has no unfriendly implications in astronomy, where it simply means "opposite." When the moon is 180° in longitude from the sun, it is in opposition. It is then full moon and the moon rises at about the time of sunset, and over the opposite part of the horizon from where the sun disappears. Thus, with the sun around the time of the summer solstice setting far toward the northwest, the full moon rises toward the southeast. In winter the sun sets toward the southwest and the full moon rises far northeast and is above the horizon about as long as the sun is in the summer. These statements apply to the Northern Hemisphere only. Conditions are reversed, for example, in Argentina, but the full moon is opposite the sun, just the same.

NEWS NOTES

By Dorrit Hoffleit

LONGEST AND SHORTEST TIMES

The element tellurium 130, formerly thought to be completely stable, has been found by scientists at the Argonne National Laboratory in Chicago to be radioactive with a half-life of about 1½ sextillion years, or about 500 billion times longer than the estimated age of the earth. The half-life is the time required for half of a substance to undergo radioactive decay; evidently only an infinitesimal part of the earth's original tellurium has had time to decay.

Tellurium's radioactivity is of a rare type known as double-beta transition, in which two negative electrons are emitted simultaneously from the nucleus of the atom involved. No change in atomic weight occurs and the tellurium becomes xenon 130, a rare gas. The Atomic Energy Commission reports that the longest known half-life was discovered from an excess of xenon 130 in samples of tellurium.

At the other extreme, the same report tells of a half-life of only one ten-trillionth of a second for the neutral meson, which "decays almost as soon as it is formed into two high energy gamma rays," a discovery made at the radiation laboratory of the University of California. According to the theory of relativity, the speed of light is the limit of the velocity of a material particle. The measured half-life of the neutral meson is so short that light itself travels only about one thousandth of an inch in that time.

NEW STYLE UNIVERSE

At the recent meeting of the American Physical Society in Mexico City, Dr. Carlos Graef Fernandez, of the Institute of Physics of the National University of Mexico, presented his new theory of the universe. It is based on Einstein's special theory of relativity and Birkhoff's theory of gravitation. Science Service reports that according to Dr. Graef the amount of matter in the universe is infinite while the volume it occupies is limited; he has developed a theoretical universe which is perfectly symmetrical in what physicists call "flat space-time."

NEW DWARF GALAXIES

The discovery at Palomar of two new dwarf stellar systems in the constellation Leo, one of which is the smallest galaxy yet found, was announced by R. G. Harrington and Albert G. Wilson, of Mount Wilson and Palomar Observatories, in a paper at the meeting of the Astronomical Society of the Pacific late in June in Salt Lake City. The two new objects bring to 16 the membership in the so-called local system. They were found on sky survey plates taken with the 48-inch Schmidt telescope.

Whereas our own galaxy has a probable diameter of about 100,000 light-years, and the smallest hitherto known have been some 3,000 light-years across, one of the new galaxies appears to be only 1,500 light-years in diameter. The existence of such small systems will have a bearing on theories of the evolution of galaxies.

MOST DISTANT SUPERNOVA

Another paper at Salt Lake City announced the discovery by Milton Humason, Mount Wilson and Palomar Observatories, of a supernova in the galaxy IC 4051, a member of the large Coma cluster of galaxies. Found on a plate taken with the 200-inch on March 20th this year, this most distant supernova is 50 million light-years away. Had it been as close as our bright star, Vega, it would have appeared to us as bright as the moon.

On April 11th Dr. Humason discovered an ordinary nova, also at an unusually great distance for its class. It occurred in the spiral M81, and was first photographed about 12 hours before it achieved its greatest brilliance. The nova (as well as the galaxy) is 2½ million light-years distant.

THE NAUTICAL MILE

"A mile a minute" is the easy schoolboy definition of the length of a nautical mile. But just what does this really mean? The neophyte sailor gets it more precisely as one minute of latitude. Lt. Comdr. Alton B. Moody, USNR, in the March number of the *Ensign*, in an article reprinted from the U. S. Naval Institute *Proceedings*, neatly describes the origin of the nautical mile as differentiated from the statute mile. He tabulates its numerous values, in feet, that are currently accepted in various countries.

First, however, it was necessary to reduce everything to United States units of measurement. The official length for the nautical mile in the United States is 6,080.20 feet, whereas in 13 other countries that Comdr. Moody lists it ranges from 6,075.45 (Spain and Portugal) to 6,085.95 (Iceland) American feet.

The difficulty arises from the inaccurate knowledge of the dimensions and shape of the earth and the selection of the particular great circle to be chosen for measuring the correspondence between the mile and the minute of arc. The official definition for the United States is "one minute of the arc of a great circle of a sphere having an area equal to that of the Clarke spheroid of 1866."

METEORITICAL SOCIETY MEETING

The 13th meeting of the Meteoritical Society will be held on Tuesday, Wednesday, and Thursday, September 5-7, 1950, at the Museum of Northern Arizona, Flagstaff, and at the Canyon Diablo meteorite crater. The scientific sessions, which will be open to the public, will begin at 9 a.m. and 2 p.m. on Tuesday and Wednesday at the Museum of Northern Arizona. The excursion to nearby Meteor Crater is scheduled for Thursday.

BOSSCHA OBSERVATORY NEWS AND A CORRECTION

A letter from Dr. Elsa van Dien sets us straight on details in a note that appeared on page 137 of the April issue. She writes from the Indonesian University at Lembang, Java, under date of May 21st, in part:

"The observatory was indeed heavily damaged during the war. Ever since the end of 1946 the rehabilitation has been taken in hand by the Indonesian government (at that time still Dutch). The large 24-inch double refractor was essentially undamaged, but it had suffered badly from neglect, and several parts had been stolen. Although the instrument has not yet been completely overhauled, we have had it in operation since August, 1949, mainly on a program of double stars. Unfortunately, we still lack almost every bit of auxiliary apparatus. Our double star plates are being measured by Dr. Hertzsprung of Tollose, Denmark (formerly of Leiden,

(Continued on page 254)

In the CURRENT JOURNALS

Where the Planets Came From, by Fred Hoyle, *Science Digest*, July, 1950. "There was once a star moving around the Sun that disintegrated with extreme violence. So great was the explosion that all the remnants were blown a long way from the Sun into space with the exception of a tiny wisp of gas out of which our planets have condensed."

The Great Meteor of 1947, by Otto Struve, *Scientific American*, June, 1950. "Little has been told of the small asteroid that three years ago crashed into a Siberian forest."

A Short History of the Lick Observatory, by F. J. Neubauer, *Popular Astronomy*, May, 1950. "The history of the Lick Observatory is interesting as a bit of Californiana. . . . It also touches upon the life and activities of men in business, finance, education, and professional work for the first forty years of the State's existence."

BOOKS AND THE SKY

THE PLANET MARS

Gerard de Vaucouleurs (translated by P. A. Moore). Faber & Faber, Ltd., London, 1950. 87 pages. 10s. 6d. Published in the United States by the Macmillan Company, New York, 1950. $2.00.

THE REVIEWER will introduce the topic of this attractive small volume by quoting from the author's foreword:

"There is no planet which has been the object of so much research and study as Mars; nor has any other planet given rise to so many controversies, heated discussions and — it must also be said — so many more or less serious books.

"Astronomers have devoted their lives to him; observatories have been dedicated to him like temples. . . . Everybody has heard of the 'canals' of Mars; these strange appearances are described by some people as proof of the industrious activity of 'Martians', yet others will not admit that they are anything but persistent optical illusions. This question of the Martian canals has given rise to interminable debates for more than half a century, and — despite the affirmations of some badly informed people — these arguments are still going on; we cannot consider them closed when numbers of qualified specialists firmly hold on to their original ideas.

"And, since many people have represented this as the crucial point of the Martian question and the eventual aim of all research, this great quarrel about the canals has brought much discredit upon the study of the planet."

The author goes on to say that such discredit is no longer justified since several reliable, scientific methods are now able to yield unambiguous results about the planet. The main part of the book is devoted to a systematic description of these more reliable data; they are described in the chapters, "The Polar Caps," "The Bright Regions of Mars," "The Atmosphere," "Climates," and "The Dark Regions of Mars." They deal, respectively, with the observed seasonal variation of the polar snows and their hypothetical thickness; the polarimetric observations of the bright regions and their implications; clouds and probable composition of the Martian atmosphere; the temperature measurements made with the aid of thermocouples; and the seasonal and irregular variations of the dark regions on the planet. These subjects are all treated well and the reader will enjoy the lucid and systematic arrangement which the author gives them. The semipopular nature of the book must be held accountable for the absence of bibliographical references which would have enhanced the value of the survey greatly. The brevity of the presentation makes the book easy reading, but some might wish for a somewhat wider coverage.

The last two chapters deal with "The Canals" and "Life on Mars?", chapters which many a curious reader may look at first. The subtitles of the sections reflect the controversial nature of the topics; two of them are quoted as illustrations — "Europe Condemns the Canals: Antoniadi" and "The Americans Defend Them: Slipher." These two irreconcilable sections are integrated by a slightly acrobatic effort entitled "A Subtle Appeal: Fournier."

The reviewer doubts whether the oversimplification expressed by the titles of these sections should have been retained in the present English edition, after Mr. Ryves in the **Journal** of the B.A.A. in 1948 signaled them in the French original. Certainly, astronomical opinion on both continents was divided, with Barnard, Hale, Campbell, and others taking views similar to that expressed by Antoniadi in France; while the astronomers at the Jarry-Desloges Observatory drew Mars in a manner somewhat resembling the drawings of Lowell and W. H. Pickering.

The situation confronting the student of Mars was ably expressed by F. J. Hargreaves in his presidential address for the British Astronomical Association in October, 1944 (**Journal**, B.A.A., **55**, 1, 1945).

"What is vision? It begins with a physical action — the formation of an optical image on the retina. Then comes a physiological operation — the optical image is converted into a complex of nervous impulses. Lastly, the mind examines and interprets these nervous impulses and we become conscious of the object under examination." After Mr. Hargreaves showed the essential equivalence of all observers with respect to the first two points, he continued, "But psychologically we differ profoundly from one another ('so many men, so many minds') and we are now confronted with the real problem — how and to what extent our individual mental processes bring about the differences in the representations of planetary markings made with similar instruments in similar conditions by different observers — and what we can do about it.

"Some people may be inclined to think that this problem does not exist; I can almost hear some of my friends saying 'Nonsense! I know what I see, and that is the end of it.' But do we all, always, know what we see? . . .

"Here is an experiment that can easily be performed by anyone. Set up a page of print at such a distance that it can be read with some difficulty. We can see the individual letters with the utmost clearness, and we make a faithful copy of them — or we imagine we do.

"Now turn a similar page of print upside down and, from the same distance as before, try to copy the words letter

by letter. We shall not succeed anything like so well. But the letters are the same as before, and it should be just as easy to copy them upside down as right way up.

"Instead of ordinary print, try a page of print in some unfamiliar characters — Greek, Kyrillic or Hebrew — and we shall find ourselves in still greater difficulties.

"The fact is that we see clearly and without any difficulty things with which we are already familiar — things that we are **expecting** to see. We have seen these letters large and plain and we are completely familiar with them. Therefore we can recognize them with ease when they are small and not so plain, so long as they are the right way up. We **think** we are seeing them plainly, but we are not; we are seeing them dimly and our minds are helping out the dimness of our vision. . . .

"Occasionally a visitor who has never observed before begins to see detail [on a planet] at once, with little or no prompting. In every such case, in my experience, it has turned out that the person in question has read books on astronomy and has seen reproductions of drawings of the planets. Such a person has less difficulty than the first because he is looking at things of the general character that he expects to see. He knows the alphabet, as it were.

"The argument is leading to a suggestion that may be unwelcome to some of us, but which demands consideration. It is this: that the character, if not the quality, of every planetary observer's work must be very largely determined or conditioned by the circumstances in which he began his observing career."

This is precisely the point. It accurately expresses the experiences of the reviewer in trying to interpret the results of different "schools" of planetary observation. As recently as April 7, 1950, he and a guest astronomer independently drew Mars visually with the 82-inch telescope at McDonald Observatory under exceptionally favorable conditions. But the two drawings came out very differently indeed, one showing several prominent "canals" and the other much delicate detail but no "canals."

The reviewer has noted only a few inaccuracies in the book under review. Plate II, 10-12, appear to be drawings from photographs, rather than photographs as stated. The hypothesis that the Martian deserts are covered with iron oxide (Fe_2O_3) had been disputed on the basis of infrared observations when the English edition was prepared, but appears on page 34. The reason for the presence of argon on Mars, as a decay product from radioactive potassium, is not stated though it has been known since 1937. The statement on page 65 of water running on an ellipsoidal planet is erroneous. Fig. 5 is not adequately explained. But, these minor points detract little from the value of this charming little book. The claim on the jacket that Mars is our nearest planetary neighbor appears slightly exaggerated.

The book does not settle the question of the canals, though a solution is suggested. It probably will not be settled completely until a new generation of visual observers who "don't know the alphabet" have observed and drawn this fascinating planet under the very best conditions with large instruments. With seeing less than 8 on a scale of 10 nothing substantially new will be added; but with essentially perfect seeing and magnifications of 700-1,000 diameters, the planet takes on a new aspect in large telescopes, giving a resolving power twice or thrice the customary one. The resolution of the Syrtis Major region by Dollfus at the Pic du Midi shows what can be done under really good conditions.

GERARD P. KUIPER
Yerkes Observatory

NEW BOOKS RECEIVED

POCKET ENCYCLOPEDIA OF ATOMIC ENERGY, *Frank Gaynor*, 1950, *Philosophical Library*. 204 pages. $7.50.

Included in this volume are definitions and brief explanations of terms and concepts in atomic energy and nuclear physics. There are individual entries for each element; descriptions of various types of nuclear reactions, short notes on general terms such as nuclear fission, periodic table; brief biographical sketches; and many charts and diagrams.

L'EXPANSION DE L'UNIVERS, *Paul Couderc*, 1950, *Presses Universitaires de France*, 108 Boulevard Saint-Germain, Paris. 217 pages and 12 plates. 500 fr. (paper bound).

Dr. Couderc, of the Paris Observatory, discusses first the known universe, its character, make-up, dimensions, and so on. He then considers non-Euclidean space-time, the universes of Einstein and de Sitter, the concept of the expanding universe, and various recent cosmological theories.

GLEANINGS FOR ATM's

EDITED BY EARLE B. BROWN

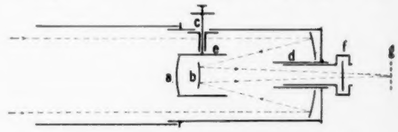
A Cassegrainian with Interchangeable Focal Lengths

UNDER the direction of the writer, an experimental model of a new type of reflecting telescope was built in 1949 by Shimazu-Seisakusho, Ltd., Japan. Although essentially a Cassegrainian, this instrument features a double arrangement of convex secondaries, enabling the effective focal length to be changed quickly from f/7 to f/12. The focal plane is located in the same position, 200 millimeters behind the main mirror, whether the longer or shorter focal length is employed, and the change from one ratio to the other may be made simply by turning a knob.

The external appearance of the instrument is shown here by two pictures, and the diagram illustrates the arrangement of the internal parts and the optical path. The two convex secondaries are mounted back to back in a single small tube that serves as the secondary cell. Both mirrors are the usual hyperboloids found in Cassegrainian telescopes, but their curves are computed and they are placed in such a way that the focal planes are in the same position, at least for astronomical objects. The primary mirror is nearly six inches in diameter.

The letters on the photograph of the instrument denote the following parts: A, telescope tube; B, finder; C, eyepiece; D, diagonals; E, filter box; F, holder for telescope tube; G, device for quick changing of secondary mirrors; H, slow motion for horizontal circle; I, slow motion for altitude; J, tripod.

The secondary cell rotates perpendicularly to the optical axis of the telescope on a shaft that is turned in a bearing tube. This, in turn, is the only support of the secondary cell. Attached to the shaft outside is a circular disk with two V-shaped notches opposite each other. A sharp edge, held against the disk by a spiral spring, drops into the notches when the secondary is properly aligned. To change the secondaries, the spring is re-



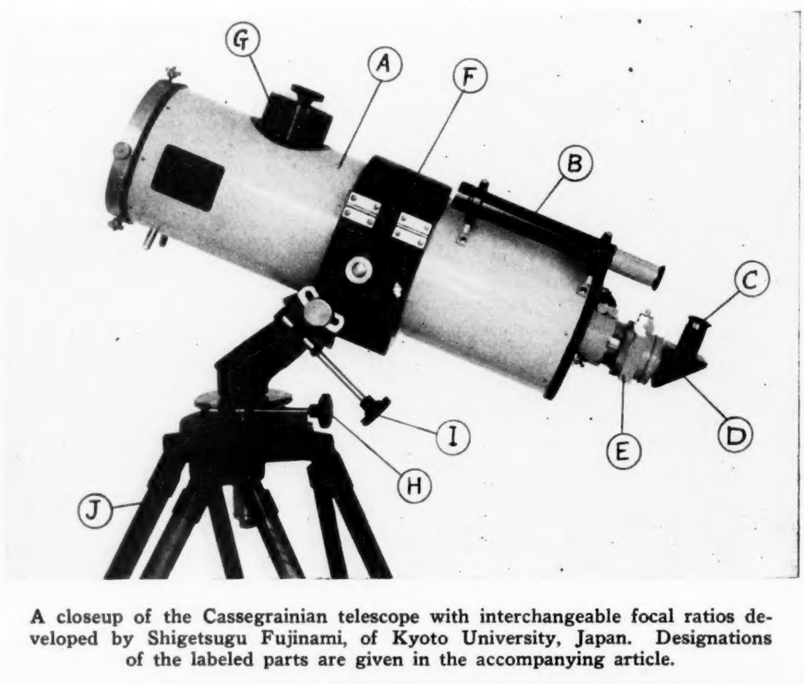
The scheme of the Fujinami dual-purpose reflector: a, secondary mirror A; b, secondary mirror B (f/12); c, apparatus for rotating secondary mirrors' support; d, hood for hole in main mirror; e, secondary mirror's hood; f, filter box and glass filter; g, focal plane.

leased by a small knob, and the cell is then turned with a larger knob. When half of a turn has been completed, the rotation is stopped automatically by the spring and notch arrangement.

The main mirror has an aperture of 150 mm.; it is a paraboloid with a focal length of 555.82 mm. Secondary mirror A has an aperture of 70 mm., radius of curvature of the paraxial sphere, 1,111.64 mm.; setting distance to main mirror, 294.22 mm.; effective focal length of 1,050 mm., making an f/7 instrument in combination with the primary mirror.

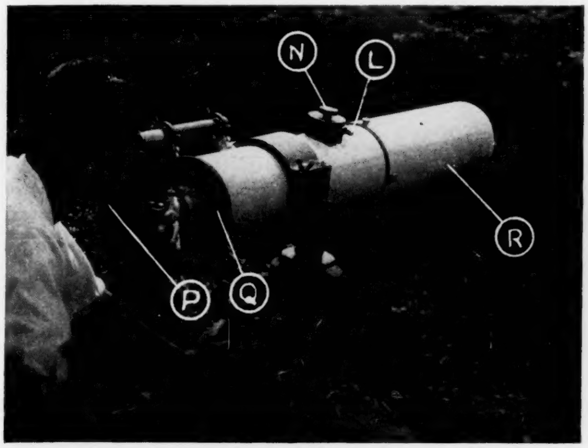
The aperture of convex mirror B is 64 mm.; radius of curvature of the paraxial sphere, 515.97 mm.; setting distance to main mirror, 377.50 mm.; effective focal length of 1,800 mm., making an f/12 telescope when it is in use.

The telescope tube has a length of 50



A closeup of the Cassegrainian telescope with interchangeable focal ratios developed by Shigetsugu Fujinami, of Kyoto University, Japan. Designations of the labeled parts are given in the accompanying article.

centimeters, plus a useful dewcap for night observing that is essential for daylight observing of terrestrial objects. Its aperture is 17 cm., and the fog baffle tube around the primary perforation has an aperture of 56 mm., and a length of 120 mm. Another fog baffle, 80 mm. long and 70 mm. wide, protects the B secondary.



Mr. Fujinami operates his dual-purpose Cassegrainian terrestrially on an altazimuth mounting. L is the lock on the secondary mirror support; N, knob for rotation of secondary mirror support; P, a reflex camera; Q, focusing knob; R, dewcap and light shield.

No fog baffle is needed for the A mirror.

A filter box is provided, and the filter glasses used for photography are 50 mm. in diameter. Either an eyepiece or a camera may be used for observing. The camera shown with the writer operating the telescope terrestrially is a Reflex-Korele. It is possible to focus on objects only 15 or 30 meters distant by resetting the film plane.

The ratio of image size between the two secondaries is 1 to 1.7 linearly and 1 to 3 in area. When astronomical observing is carried on, the shorter focus secondary A is effective for nebulae, clusters, comets, and the like. The longer focus of the B secondary is effective with brighter objects such as the sun, the moon, and the planets. Telephoto results with the B combination are illustrated by the accompanying picture of the rising full moon.

Successful terrestrial photography may

An f/12 photograph of the rising moon on Higashiyama, Kyoto, exposure 1/2 second on Fuji Panchro film. Note the telephoto effect.

GLEANINGS is always ready to receive reports and pictures of amateur instruments and devices, and is open for comment, contributions, and questions from its readers.

An f/7 photograph of the Kurodani Temple, at a distance of one kilometer, exposure 1/25 second on Fuji Panchro film with an orange filter.

be carried on to great distances, as shown by the picture of Kurodani Temple, taken by the writer at a distance of one kilometer on Daimonji Hill in east Kyoto. The diameter of the field is six centimeters linearly, and the field of view of the f/7 system is 3°.4; it is 2° with the f/12 arrangement.

At present the writer is supervising further work by the same manufacturers on another experimental model, in an attempt to simplify further the mechanism here, which has been patented by the Japanese government.

SHIGETSUGU FUJINAMI
Astronomical Institute
University of Kyoto, Japan

NEWS NOTES

(Continued from page 249)

Holland). Relatively large sums have been spent last year by the Indonesian government on an outfit for our workshop, and on some parts for our photoelectric photometer. We hope to have the latter in operation this coming dry season.

"As to the UNESCO gift of a 3-foot mirror, it does not seem correct to mention the observatories of Leiden and Louvain as participating in the reconstruction. UNESCO is going to make us a gift of a 3-foot mirror, which is one out of four that are being ground in the Yerkes shops (or rather the shops of the University of Chicago). The other three are to go to Chicago, Leiden, and Louvain. The fact that four similar ones are made at the same time causes the price of the mirrors to be rather low, and that is the only way in which Louvain and Leiden are helping us indirectly in this matter. I should add that we have the help of Leiden, especially of Dr. Oort, in many matters. The question of the design of a dome and mounting for this telescope is entirely up to us. UNESCO, through Mr. Ellis, the field science officer in Manila, is also going to help us by ordering about a year's need of photographic plates."

SYMPOSIUM ON THE GALAXY

(Continued from page 245)

and four per cent of the mass of our galaxy. The Large Cloud is apparently well above the average galaxy in size and mass, and is hardly to be considered as a satellite of the Milky Way. Its overall diameter is 17,000 light-years; that of the Small Cloud is about 11,500 light-years. These dimensions seem consistent with the masses of these systems.

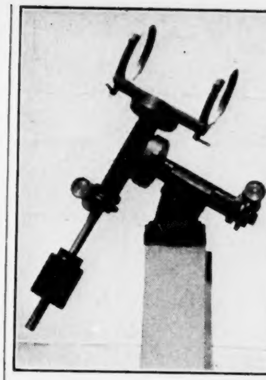
In type the clouds differ as much from our galaxy as M32 and NGC 205, the spheroidal companions of the Andromeda spiral, differ from that system. In the structural sequence of galaxies the clouds are at one end as irregulars, while our galaxy is in the middle, if we are right in calling it type Sb, or possibly Sab or Sbc, Dr. Shapley suggested.

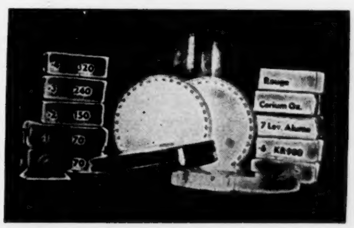
The star population of the Magellanic Clouds is comparable to that in the spiral arms of our galaxy and unlike that of globular clusters or the galactic nucleus. Dr. Shapley believes that in the sequence of ages or stages of galactic evolution the clouds may be earlier than the Sb spirals — whatever evolution there may be along the structural sequence is in the direction from the irregular and most open galaxies toward the tighter spirals and to those classed as ellipticals. Micrometric measures show that the typical elliptical galaxies are not sensibly smaller than typical spirals.

The dedication ceremonies for the Heber Doust Curtis memorial telescope took place Saturday morning, June 24th, following the day of the symposium. Dr. Leo Goldberg, director of the University of Michigan Observatories, presided; President Alexander G. Ruthven, of the university, and Kenneth L. Moore, representing the McGregor fund, both spoke. Dr. Joel Stebbins, of Lick Observatory, delivered the principal address.

Dr. Stebbins recalled personal incidents in his acquaintance with Dr. Curtis, and then went on to show how Dr. Curtis' early photographs of bright galaxies at the Lick Observatory laid the foundation for a rapid advance in galactic astronomy. As director of the University of Michigan's observatories for more than a decade, Dr. Curtis had planned a 98-inch reflector, and he had even procured the disk at the time the 200-inch blank was cast. This disk is now in England, and its place at Michigan is taken by the new Schmidt camera.

"Since the installation is practically a duplicate of the Case telescope in Cleveland," remarked Dr. Stebbins, "we have a guide to the minimum of what may be expected, but the additional advantages of the darker sky away from the lights and smoke of a city, even away from Ann Arbor, promise greater effective power. . . . And so today we are confident that the work of the new telescope will be carried on in the tradition and spirit of Heber Doust Curtis."





OBSERVER'S PAGE

Universal time is used unless otherwise noted.

Visual Observing Programs for Amateurs — V

Instruments — (continued)

REFLECTING TELESCOPES. Some amateurs live where they can set up a large reflector on a permanent mounting, but unless one is so situated a 6-inch f/8 Newtonian reflector is the largest convenient size. Twenty years ago I built 8-inch and 12-inch Newtonian reflectors, and for about six years I used an 8¾-inch reflector of semiprofessional make, but I found these larger telescopes inordinately heavy to move around and set up, and it was necessary to use boxes and ladders to stand on to reach the eyepiece.

The illustration shows a 6-inch reflector which I made in 1947 and took to Florida in my car so as to see Mars and Saturn under favorable conditions. It has no circles or slow motions, and this keeps down its weight. The fork-type mounting is steady enough so that a 144x eyepiece can be used, and it gives a maximum of convenience with a minimum of weight. If looking at circumpolar stars I pick the entire ensemble up and turn it around to a suitable position.

The following items in design contribute to good performance of this instrument. The tube is 9" inside diameter and lined with ⅛"-thick cardboard to act as heat insulation. The flat diagonal has six degrees of freedom of motion, for accurate adjustment. The focusing rack and pinion is short and stubby, so that the eyepiece can be in close to the side of the tube. The finder has its own base; thus, the entire finder "subassembly" can be removed and replaced without the necessity for realignment. The black cover on the mirror end of the tube can be removed to ventilate the mirror and tube to secure steady seeing. The mirror is mounted in an open type of cell that permits good air circulation. The tube rests in a cradle and the telescope can be moved longitudinally for balance. It can also be rotated on its axis to bring the eyepiece to a reasonably convenient position, no matter what part of the sky is under review. But in practice such twisting of the telescope tube changes the orientation of the field of view, making it hard to identify variable stars and awkward to sketch the planets, so the telescope is usually set up with its eyepiece looking west as shown, although it is difficult to see through it in an area west of the zenith.

The yoke mounting is made of heavy strap iron, brass bearing plates, and pipe fittings. The cast-iron base was originally made for an 8¾-inch reflector, for which it was too light. The telescope is portable in two parts. First the base and head are set up; then the telescope in its yoke is carried out and the polar axis is slid down into the polar-axis sleeve supported by the base.

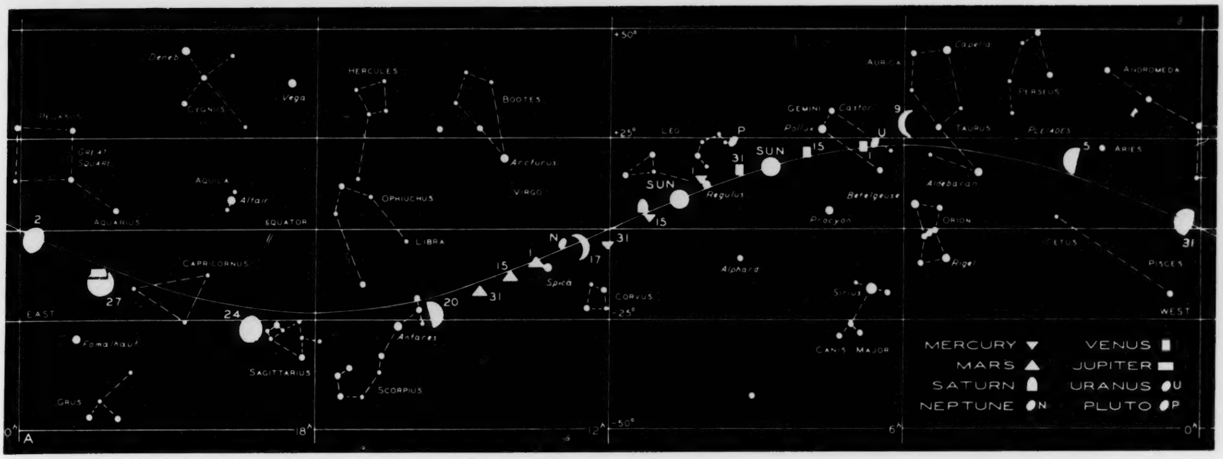
For variable star work a double achromatic (or symmetrical) eyepiece of 1¼-inch effective focal length can be used. This gives a power of 38x and a field of 1.25 degrees, very handy for variable stars in the range of magnitudes 8 to 12½. A 16-mm. orthoscopic eyepiece with a power of 76 will show variable stars to 13.5 magnitude, and gives excellent views of Jupiter. A 1/3-inch orthoscopic eyepiece of 144x, or a 16-mm. orthoscopic eyepiece with a 3x Barlow giving 228x, gives good views of Mars and Saturn. It is necessary to allow the planet under observation to drift across the field of view and then to move the telescope a little too far so that the object will again drift across the field. This is, of course, not as good as a slow motion, but much can be seen nevertheless.

Like any Newtonian, it can be used terrestrially if the eyepiece looks vertically downward and the observer stands with his back to the landscape. This is not very convenient, however.

The instrument cannot be used on the sun, for if a reflection off unsilvered glass is introduced (Herschel wedge effect, which is absolutely essential for the safety of the observer's eyes), one cannot bring the telescope to a focus. If it had been built to focus with a Herschel wedge in the optical train, the diagonal would have had to be some three inches nearer the primary mirror — either an undesirably large diagonal would have to be used, or one would lose light around the edges of the field of view by vignetting. As built, this reflector gives full light grasp on stars central in the field of view, and with a 1⅜" diameter elliptical flat the definition is not spoiled by a large diagonal. As I see it at present, if a small reflector is to be used for direct visual solar work it must be specifically designed for the purpose. I have such a telescope "in the works," but it will be some time before I am able to complete it.

This simple 6-inch reflector on its fork mounting is well within the power of any serious-minded amateur to make, and is in fact about the lightest and most power-

David W. Rosebrugh's 6-inch f/8 portable reflecting telescope.



ful telescope that can be devised. Nevertheless, unless one is an extremely capable optician and machinist, there are many parts that must be bought. All items except the 16-mm. and 1/3-inch orthoscopic eyepieces and the 3x Barlow were bought secondhand, or from war surplus, at bargain prices. Despite this I estimate that I have spent about $130 on this instrument. Purchased were mirror supplies, mirror cell, finder, rack-and-pinion focusing device, three eyepieces, and cast-iron base. The items made were the tube and lining, diagonal support, finder support, dust caps, the fork mounting, plus the general assembly. Including time spent on the mirror, some 175 hours of work went into making and assembling this instrument.

Larger Reflectors. My limited experience with my 8-inch and 12-inch Newtonian telescopes, and the 8¾-inch reflector that I used from about 1941 to 1947, leads me to believe that such instruments are principally of value for club observatories, as the individual observer will not usually find it feasible to install and operate conveniently such large and weighty telescopes.

A Springfield-mounted reflector is, however, an exception to the above. Because of its fixed eyepiece design with all controls ready to the hand, an individual observer can use it conveniently. However, good alignment on a permanent pier is required. The observer sits on an elevated seat, as the mirror end of the reflector must swing clear of the ground.

Cassegrainian Reflectors. I have had no experience with these. Indirectly, I hear that they are difficult to keep in adjustment. The rough-and-ready amateur like myself needs something which will stand occasional hard knocks, and the rugged nature of refractors and Newtonian reflectors is a decided advantage.

DAVID W. ROSEBRUGH
79 Waterville St.
Waterbury 10, Conn.

UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, and the result is your standard time on the day preceding the Greenwich date shown. Add one hour for daylight time.

THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

Mercury, in the evening sky all month, reaches greatest elongation on August 21st. It will be 27° 24′ east of the sun in longitude, almost as far as Mercury ever wanders from the sun. However, this will be a poor elongation as concerns the Northern Hemisphere, as the planet is situated south of the sun. The best time to find Mercury will be early August, when it sets one hour after the sun and is zero magnitude. Observers in southern latitudes may view Mercury all month.

Venus now rises shortly before dawn, preceding the sun by two hours. Telescopically, Venus is of little interest; it is 11″ in diameter, and the disk appears at nearly full phase, 91 per cent illuminated.

Moon. The ascending node of the moon crosses the vernal equinox on August 18th, completing a cycle of the regression of the nodes. This westward motion of the nodes (the points where the moon's path crosses the ecliptic) has a cycle of a little under 19 years. The ascending node is the northward crossing; therefore, about 90° from this point the moon is 5° north or south of the ecliptic, and the change in altitude of the moon is 57° in 13 days, the greatest extreme. Nine years hence, the change will be only 37°, when the descending node is at the vernal equinox. (For a general discussion of nodes, see the Observer's Page for March, 1949.)

Mars, no longer an attraction in the sky, sets three hours after the sun. It is east of Spica in Virgo, and only slightly brighter than the star.

Jupiter, at −2.4 magnitude, reaches opposition with the sun on August 26th, 371 million miles from the earth. The planet is an excellent telescopic object with its four bright satellites and large disk. The equatorial diameter is 49″, far exceeding any other planet.

Saturn, low in the west at sunset, may be followed with difficulty till mid-August. On the 16th, Mercury and Saturn will be in conjunction, Saturn 3½° north, visible with field glasses. It continues to be of interest due to the ring system. Telescopic observation will be exceedingly troublesome due to the planet's low altitude. The rings close from 2°.5 to 0°.9 in August, and will be edge-on September 14th.

Uranus may be first observed in the morning sky at the end of August. Rising three hours before the sun, the planet is located 2° southwest of Epsilon Geminorum and is of 6th magnitude.

Neptune, in Virgo, is poorly placed for observation.

E. O.

PREDICTIONS OF BRIGHT ASTEROID POSITIONS

No. 39		**Laetitia**		Mag. 8.8	
		h	m	°	′
Aug.	7	22	56.0	−5	02
	17	22	51.3	−6	22
	27	22	44.8	−7	53
Sept.	6	22	37.6	−9	27
	16	22	30.8	−10	57
	26	22	25.7	−12	16
No. 511		**Davida**		Mag. 9.3	
Sept.	6	1	02.4	−16	46
	16	0	57.3	−18	08
	26	0	50.7	−19	19
Oct.	6	0	43.3	−20	14
	16	0	35.9	−20	47
	26	0	29.4	−20	54

The above are predicted positions in right ascension and declination for the epoch 1950.0, for 0^h Universal time. The magnitude is that expected at opposition. In each case the motion of the asteroid is retrograde.

VARIABLE STAR MAXIMA

August 2, RS Scorpii, 6.8, 1648**44**; 9, RT Sagittarii, 7.9, 2011**39**; 18, R Aquarii, 7.3, 2338**15**; 22, V Cassiopeiae, 7.9, 230759; 27, S Hydrae, 7.9, 084803. September 5, S Canis Minoris, 7.5, 072708; 6, R Ursae Majoris, 7.6, 103769.

These predictions of variable star maxima are by Leon Campbell, honorary recorder of the AAVSO. Only stars are included whose mean maximum magnitudes, as recently deduced from a discussion of nearly 400 long-period variables, are brighter than magnitude 8.0. Some of these stars, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the predicted magnitude, and the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern).

DEEP-SKY WONDERS

THE renowned Dumbbell nebula in Vulpecula, NGC 6853, M27, located at $19^h\ 57^m.4$, $+22°\ 35'$, measures $8'$ by $4'$ in photographs that show its unmistakable spherical outline and the central star. However, to the eye, in amateur-sized telescopes, no trace of the essential planetary nature of this object can be seen. The dumbbell description is most accurate to such observers.

This difference between visual and photographic registration is common in the nebular field. Visual scrutiny cannot gain much idea of the dark lanes in M31; and, while M13 photographs as a round-edged cluster, the amateur sees it as roughly rectangular with streams of small stars trailing from various portions of its edge. The Orion nebula, on the other hand, appears to the eye much as it does to the photographic plate.

M27 is easily located if the observer finds the arrow of Sagitta and moves to the easternmost star, Gamma. About three degrees due north of this star will be seen an inverted W, or M, composed of the stars numbered by Flamsteed 12, 13, 14, 16, and 17 Vulpeculae. If 14, the middle star of the W, is found in the telescopic field, a sweep of half a degree due south will discover the dumbbell. According to the **Handbook** of the Royal Astronomical Society of Canada, it is of the 8th magnitude.

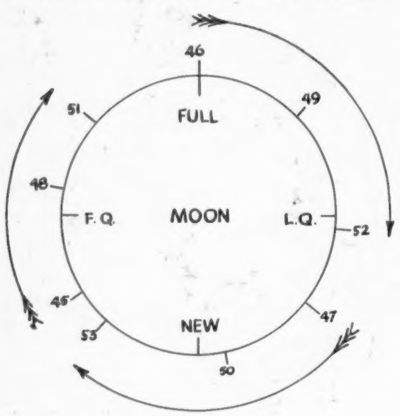
WALTER SCOTT HOUSTON

The Dumbbell nebula, photographed by Claude Carpenter, 22 minutes exposure with a 12½-inch reflector, at f/7.

PERSEIDS AND THE MOON

Excellent observing as regards the moon will prevail for the Perseid meteors this year. New moon occurs on the 13th, one day after the Perseid maximum.

The lunar phase is always important in relation to meteor showers. A generality may be noted that every three years the moon's phase for a particular shower is almost the same. Also, on succeeding years, the moon will be advanced about one third ahead in phase, or more exactly ⅜. On the same date, say August 12th, the moon will be past first quarter in 1951, and in 1952 very nearly at last quarter. Then in 1953 the moon will be approximately new once more, as it is in 1950. This general rule of figuring ⅜ advancement of the lunar phase annually for any particular date may be reckoned up to 10 years backward and forward before losing accuracy.



The approximate phase position of the moon at the time of Perseid maximum, August 12th, from 1945 to 1953. The arrows show the advance every six years. Leap year spoils the symmetry of the changes somewhat.

Returning to the Perseids, the limits of the shower occur from August 4th to the 16th. The rates increase slowly till maximum on the 12th, then rapidly fall off. Rates are 50 per hour after midnight on the 12th, with dark skies. There should be many bright and trained meteors. The meteors are swift, and radiate from a point near Eta Persei.

Plotting of meteors is of value if done by experienced observers. For others, counting meteors in periods of half an hour or one hour, or recording facts as to brightness or type, will add to the attraction of meteor observing. The American Meteor Society, under Dr. Charles P. Olivier, is always glad to receive all recorded reports of meteor observations. The address is Flower Observatory, Upper Darby, Pa.

EDWARD ORAVEC

PHASES OF THE MOON

Last quarter	August 5, 19:56
New moon	August 13, 16:48
First quarter	August 20, 15:35
Full moon	August 27, 14:51
Last quarter	September 4, 13:53

August		Distance	Diameter
Apogee	6^d 15^h	251,200 miles	29′ 34″
Perigee	20^d 5^h	229,800 miles	32′ 19″
September		**Distance**	**Diameter**
Apogee	3^d 10^h	251,300 miles	29′ 33″

MINIMA OF ALGOL

August 2, 0:27; 4, 21:16; 7, 18:04; 10, 14:53; 13, 11:42; 16, 8:30; 19, 5:19; 22, 2:07; 24, 22:56; 27, 19:43; 30, 16:33. September 2, 13:22; 5, 10:10.

These predictions are geocentric (corrected for the equation of light), based on observations made in 1947. See **Sky and Telescope, Vol. VII**, page 260, August, 1948, for further explanation.

OCCULTATION PREDICTIONS

August 6-7 **27 Tauri m** 3.8, 3:46.2 +23-54.1, 23, Im: **A** 4:46.2 +0.9 +2.1 20. Em: **A** 5:22.6 −0.3 +0.8 297; **B** 5:24.8 −0.4 +0.7 304.

August 20-21 **Pi Scorpii** 3.0, 15:55.8 −25-58.3, 7, Im: **A** 0:02.5 −1.9 −0.3 75; **B** 23:59.8 −1.9 −0.3 73; **C** 23:54.1 −2.1 −0.2 83; **E** 23:24.5 −2.0 +0.2 96; **F** 23:13.0 −1.6 −0.4 124; **H** 22:53.7 0.0 −0.9 156. Em: **A** 1:11.0 −1.6 −1.6 314; **B** 1:04.6 −1.5 −1.5 318; **C** 1:08.8 −1.8 −1.5 310; **D** 0:58.1 −1.6 −1.4 315; **E** 0:42.7 −1.7 −0.9 306; **F** 0:34.8 −2.2 −0.4 285; **H** 23:48.0 −2.0 +1.2 257.

August 22-23 **W Sagittarii** 4.3-5.1, 18:01.8 −29-35.1, 9, Im: **A** 23:05.4 −1.6 +0.7 96; **C** 22:56.3 −1.5 +0.6 106. Em: **A** 0:25.0 −1.9 +0.2 271; **C** 0:14.7 −2.0 +0.5 265.

For standard stations in the United States and Canada, for stars of magnitude 5.0 or brighter, data from the **American Ephemeris** and the **British Nautical Almanac** are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, UT, **a** and **b** quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

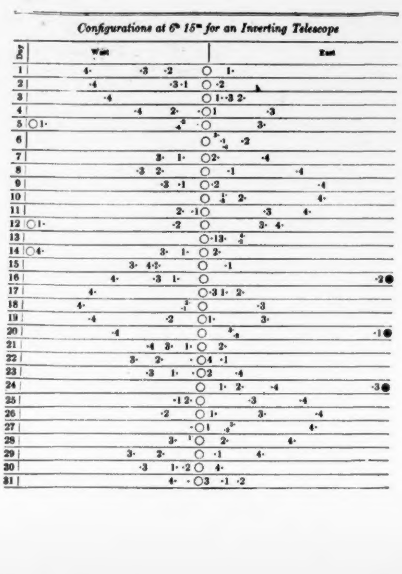
The **a** and **b** quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computations of fairly accurate times for one's local station (long. **Lo**, lat. **L**) within 200 or 300 miles of a standard station (long. **LoS**, lat. **LS**). Multiply **a** by the difference in longitude (**Lo — LoS**), and multiply **b** by the difference in latitude (**L — LS**), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

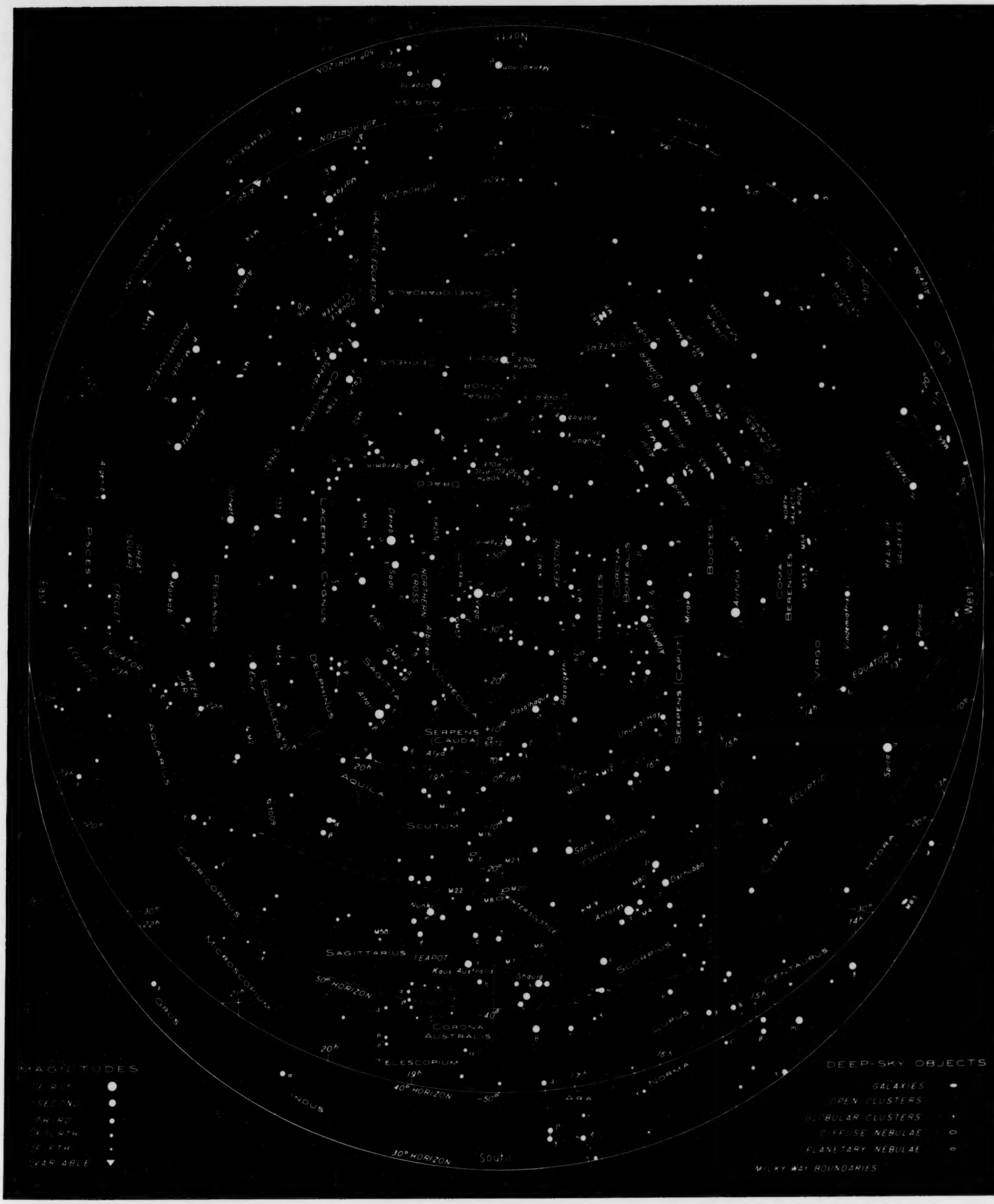
Longitudes and latitudes of standard stations are:

A +72°.5, +42°.5	**E** +91°.0, +40°.0
B +73°.6, +45°.6	**F** +98°.0, +30°.0
C +77°.1, +38°.9	**G** +114°.0, +50°.9
D +79°.4, +43°.7	**H** +120°.0, +36°.0
I +123°.1, +49°.5	

JUPITER'S SATELLITES

Jupiter's four bright moons have the positions shown below for the GCT given. The motion of each satellite is from the dot to the number designating it. Transits of satellites over Jupiter's disk are shown by open circles at the left, and eclipses and occultations by black disks at the right. Reproduced from the **American Ephemeris and Nautical Almanac.**





The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of August, respectively.

STARS FOR AUGUST

THE MILKY WAY stretches overhead in full splendor this month. In the south we look toward the galactic center, some 30,000 light-years away, beyond the dense starclouds of Sagittarius and Scorpius. North of these regions we see the brilliant starcloud in Scutum. The constellation itself, consisting of several 4th-magnitude stars, is one of the more recent groupings. The name Sobieski's Shield was a posthumous reward to the Polish hero, John Sobieski, for saving Vienna from the Turks. The appearance of Halley's comet in 1682 simultaneously with the Turkish advance alarmed Europe, so it was a natural thought to associate Sobieski with a "sign in the sky." Hevelius selected this area, studded with star clusters.

Contrasting to Scutum Sobieski is Aquila, an ancient constellation dating 1,200 years before Christ. Altair, the brightest star of the group, means "soaring eagle." Just north of Altair is Tarazed, "the thief," and to the south, Alshain, meaning "white falcon." With Altair they form one of the most conspicuous of summer skymarks.

CHART CORRECTION: In this chart the Greek letters for Alpha and Beta Cassiopeiae should be exchanged.